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THE MONTHLY MICROSCOPICAL JOURNAL:

TRANSACTIONS

OF THE

ROYAL MICROSCOPICAL SOCIETY,

AND

RECORD OF HISTOLOGICAL RESEARCH

AT HOME AND ABROAD.

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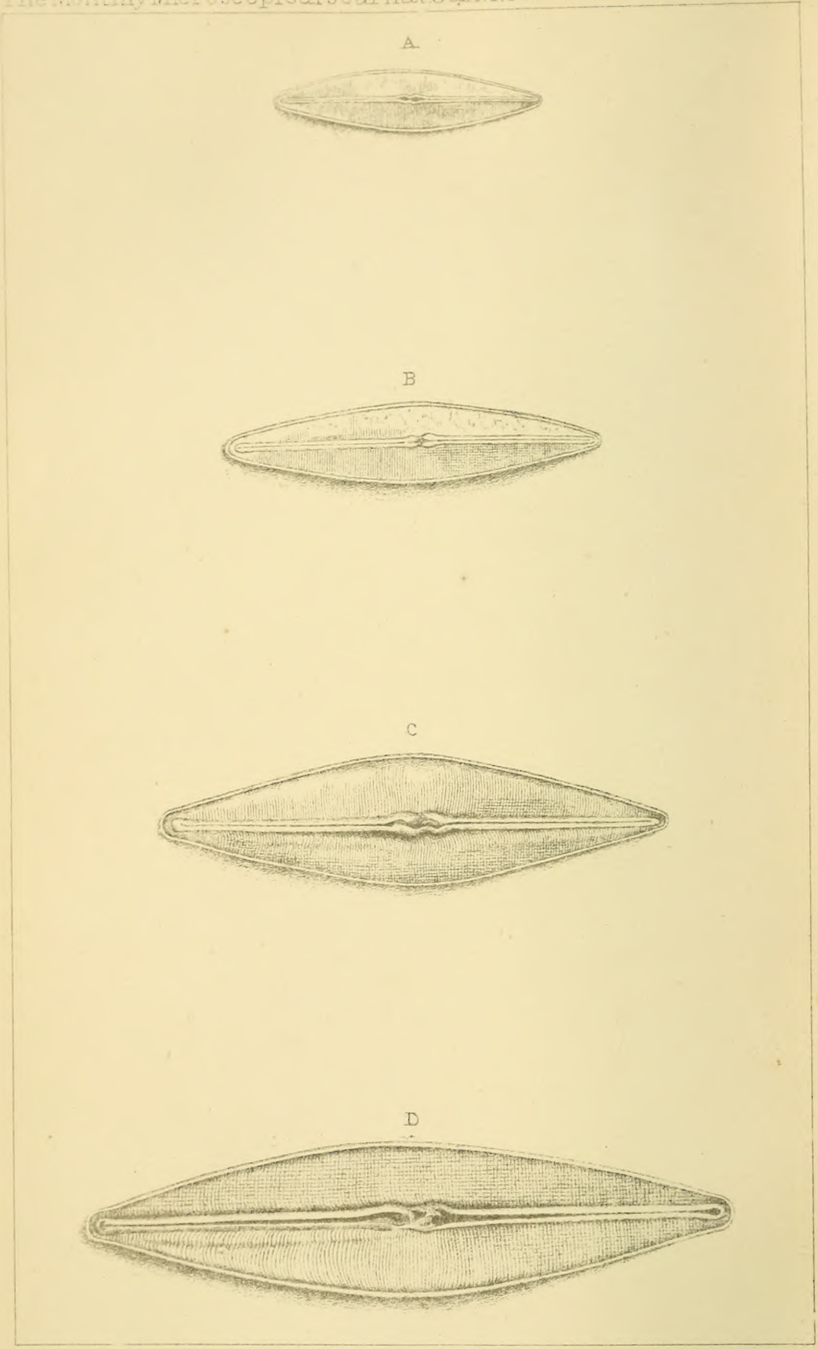

W. West & Co. lith.

Identity of N. crassinervis. F. Saxonica and N. rhomboides.

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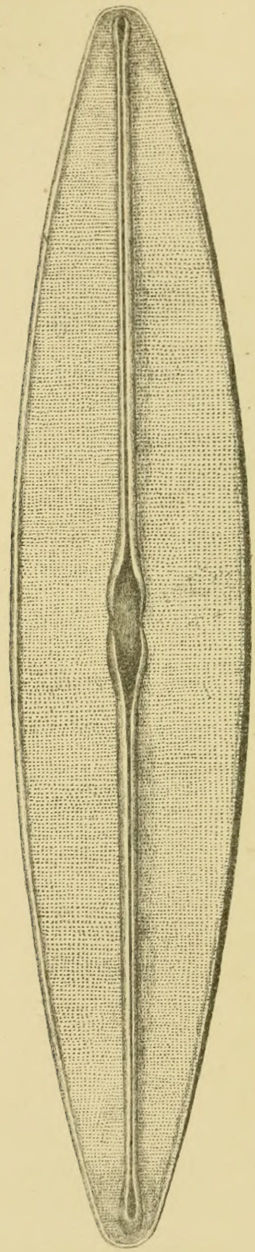

W. H. Dallinger del. ad nat. W. West & Co. lith.

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THE

MONTHLY MICROSCOPICAL JOURNAL.

JANUARY 1, 1877.

I.—*On "Navicula crassinervis," "Frustulia Saxonica," and Navicula rhomboides, as Test-objects.*

By Rev. W. H. Dallinger, V.P.R.M.S.

(*Read before the* Royal Microscopical Society, *December* 6, 1876.)

Plates CLXV. and CLXVI.

Amongst competent authorities there appears to be no longer any dispute as to the true relations of the diatoms that have hitherto received the separate designations in the above title. Professor H. L. Smith of America, and Mr. Kitton of our own country, doubtless two of the most competent living authorities, are agreed that they are but three names for the same species; for both "*N. crassinervis*" and "*F. Saxonica*" have no real existence, being but forms of *N. rhomboides*.* But the vicissitudes through which opinion and conviction have passed, in less than two years, as precursive of this valuable conclusion, are interesting. In May, 1875, Mr. Hickie, without the slightest doubt, declared *F. Saxonica* and *N. crassinervis* to be distinct species; and his conviction was reached not hastily, but after a study of the literature of the subject, after a careful investigation of his own collection of *F. Saxonicas*, which was "a pretty extensive one," and after examining it, as a form properly entitled to its name, in company with Dr. Rabenhorst, "both the discoverer and namer of the diatom in question."† Besides which, he gives evidence, then clearly satisfactory to his own mind, that these three diatoms must be different, from the fact that to properly resolve them, they must be each placed differently in relation to the source of light.‡

But the great end he had in view was, to correct what he held to be a misconception on the part of Dr. Woodward as to the existence of longitudinal striæ on "*F. Saxonica*"; which Dr. Woodward considered to be illusory, and which Mr. Hickie declared to be real; and the reality of which he contended was not only assured by the evidence he brought, but by their having been perfectly photographed by Herr Seibert.

To this, with his usual thoroughness, and the aid of his match-

* 'M. M. J.' vol. xv. pp. 278–281. † Ibid. vol. xiv. p. 33. ‡ Ibid. p. 35.

less skill in micro-photography, Dr. Woodward replied; * reaffirming his conviction that the "longitudinal striæ of Dippel," and, in addition, those announced to have been seen by Mr. Hickie, were due to diffraction and interference; the spurious lines produced by which, he declared and proved, could be as readily photographed as real ones. Some beautiful photographs in support of this were sent; and certainly to the skilled observer there can be no question that in the case of the frustules photographed by Dr. Woodward (and excellently reproduced in this Journal †) the lines photographed *are* spurious. Further, whoever has taken note of Dr. Woodward's skill in manipulating test and other difficult objects, will want no assurance, that in reference to the frustules in the photographs, if they could not be developed by Dr. Woodward, the probability is that they could not be developed at all. But this observer adds a note of extreme significance in this relation; for he says, "At the same time I shall be very glad if he (Mr. Hickie) can convince me, by satisfactory evidence, that this belief is erroneous, for analogy inclines me towards the opinion that in both *Frustulia Saxonica* and *Amphipleura pellucida* the striæ are really rows of beads, as is so easily to be seen in *Navicula rhomboides, and that consequently we ought to be able to see longitudinal striæ when the illuminating pencil has the proper direction, if only our glasses had the requisite defining power.*" The italics are mine, but they show the sound and unbiassed view of the writer.

A rejoinder is now given by Mr. Hickie. ‡ In this occurs a letter from Dr. Rabenhorst, declaring the longitudinal striæ of *F. Saxonica* to be real, and affirming that "if Dr. Woodward maintains that *Frustulia Saxonica* is identical with *Navicula crassinervis* we must suppose that he is ignorant of one or other of them." At the same time Herr Seibert's photographs of the longitudinal as well as the transverse striæ of a reputed "*F. Saxonica*" were presented to this Society for inspection. At the discussion which followed the reading of this paper it was affirmed that the photographs were simply indistinguishable from "coarse *Rhomboides*," § and in both the paper and the discussion Mr. Hickie retracted "a previous erroneous statement," and confessed that he was unable to "state where *Frustulia Saxonica* ends and 'small' *Rhomboides* begins." ‖ They were in fact identical. But he still maintained that "there was a very great difference between them and *Crassinervis*." ¶

After this, in a subsequent paper, ** Dr. Woodward definitely proved that Herr Seibert's photograph, purporting to be "*F. Sax-*

* 'M. M. J.' vol. xiv. pp. 274–281. † Ibid. ‡ Ibid. vol. xv. p. 122.
§ Ibid. vol. xv. p. 103. ‖ Ibid. p. 127. ¶ Ibid. p. 104.
** Ibid. p. 209.

onica," was, what it had been by some competent judges affirmed to be, "a coarse form of *Rhomboides*." Mr. Charles Stodder then adds a concise note,* giving reason and authority for believing that both *N. crassinervis* and *F. Saxonica* are but forms of *N. rhomboides;* and Dr. H. L. Smith's most valuable and conclusive letter follows;† and in this it is shown that not only is there identity between the three diatoms in question, but that all important authorities, Rabenhorst excepted, are agreed in the admission of that identity. To this letter Mr. F. Kitton, who had been requested by Professor H. L. Smith to revise the proofs, takes the opportunity of stating that he fully agrees "that the genus *Frustulia* should be abolished;" and he is also of opinion "that *Navicula crassinervis* is only a form of *N. rhomboides*." He adds, "*I may also state that my friend Mr. Hickie is of the same opinion.*" Clearly therefore Mr. Hickie's conviction of the "very great difference" existing between *N. rhomboides* (into which *F. Saxonica* had now been fused) had been overcome. The reasonings or facts which accomplished this in Mr. Hickie's case are not given us; but his frankness and candour are sufficient evidence of the scientific spirit in which his inquiries were conducted.

So far, it is clear, that these three diatoms are, on the best authority, accepted as mere conditions of the one form, *N. rhomboides*. The reasons for this decision have relation to morphology and development, quite as much as to the characteristics of the silicious skeleton with which the microscopist is more generally concerned. With the former of these reasons I may not concern myself, but receive them thankfully from competent authority. But with the latter facts I will venture briefly to deal.

Nothing up to this time is finally before us, as to what kind of "resolution" these various conditions of *Rhomboides* may be expected to yield, or what their real value, as tests, is.

My first acquaintance with this diatom was made some eight or nine years since. It had lain in my cabinet for some years before this: but some exquisite specimens prepared and mounted by L. Hardman, Esq., were courteously given me by him, and I did my best at that time with them. They were what I presume have been called "small *Rhomboides*"; for the largest of them taxed the power I then possessed, to develop their transverse striæ sharply and well, with a good English $\frac{1}{8}$th, and the *smaller* of them were so fine, as to resist all the manipulative skill I then possessed with a $\frac{1}{12}$th, and some of the minute ones, even with Powell and Lealand's $\frac{1}{16}$th (dry).

Coming from so excellent an authority on diatoms as Mr. Hardman, I accepted these as normal specimens of the species; and as my manipulative skill increased with practice, and my

* 'M. M. J.' vol. xv. p. 265. † Ibid. p. 279.

battery of lenses became improved, I was enabled to resolve into hemispheres all the larger, and most of the medium-sized ones, and eventually to consider myself master of the resolution of this diatom; a work which I accomplished not for its own sake, but merely to have a given set of marked tests, of known value to myself, for the sake of future comparison. When therefore the value of "*F. Saxonica*," as a test for high powers, was announced, I proceeded at once to procure it. My first specimens were got from London; but to my surprise the forms sent under this name were neither more nor less than the medium-sized frustules of my now well-worked specimens of *N. rhomboides*. I of course concluded that there was an error in naming, and at once wrote off to two other sources for the form I required. To my great vexation, these were merely repetitions of what I had received before, one of them containing really coarser specimens than any I could find on Mr. Hardman's slides of *N. rhomboides*. Determined to obtain the right frustules, I wrote to an English friend, then in Germany, and was favoured with specimens, slightly smaller, but in every sense identical with those supplied from English sources. I failed to discover a single difference between them. I could striate, or resolve them into dots, precisely as I did my *N. rhomboides*. Their midribs—a very characteristic feature—were precisely like *Rhomboides*, and their general contour varied, as *N. rhomboides* varies, some frustules having an inclination to an obtuse angle in the centre of the margin, while others preserve in their margin a continuous curve.

I had never made the natural history of diatoms a study; so the inference I was obliged to make was, that there must be some morphological or developmental difference between these diatoms which justified the difference of name: but as *tests* I determined that there was certainly no difference between them.

When I first obtained *N. crassinervis*, my difficulty was almost as great; for although the frustules on the slides so named were certainly much smaller than the *majority* of frustules on my specimens of *Rhomboides*, still I *could* find *some* almost, if not quite, as small; and I could detect, in an examination of a number of specimens, nothing that had not its complete equivalent in the frustules of *Rhomboides*. I felt therefore bound to conclude that, as *test-objects*, these three separately named diatoms were merely *Rhomboides* of various sizes, and therefore, generally speaking, of greater or less difficulty in "resolution." I reached this conclusion nearly three years since, but as it was an opinion formed on the silicious frustules alone, and had no connection with the natural history of the form, I merely set it aside for what I considered it worth. But as competent authorities have now—fully knowing the nature of the plant—determined that the three forms in

question are but conditions of the one form (*Rhomboides*), it appears to me that some interest attaches to the fact that proofs of this may be obtained by a serial study of the *silicious frustules*, from the smallest or most dwarfed, to the largest or most developed; and that such a study brings out plainly what value should be attached to this diatom as a *test-object.*

I have now a very considerable collection of these forms, gathered from many sources, and through the courtesy of many friends; but I rarely find, amongst the very finest and minutest of them, any frustules that will not yield complete resolution into hemispheres, with Powell and Lealand's "new formula" $\frac{1}{8}$-inch objective (immersion), with one or other of the methods of illumination I now employ; using as the source of light a broad-wicked paraffin lamp with the flame turned edgeways to the condenser. Unfortunately time has never been sufficiently at my disposal, to enable me to make micro-photography my servant in study. But as the objects I have concerned myself with during the greater part of my life as a microscopist, have been swiftly moving vital ones, in the portrayal of which even photography could have been of no service, I have been obliged for some years to cultivate, with as much care as I could exercise, an accurate and delicate use of the pencil, in fixing permanently the images of objects which the microscope revealed. I believe in this instance its aid may be called in with some service.

Having satisfied myself of the absolute similarity, in ultimate structure, of all the modifications of what we shall hereafter know as *N. rhomboides*, it appeared to me advisable to take one of the smallest of the forms hitherto labelled "*N. crassinervis*," and find the least magnifying power that would perfectly resolve it, and then employ the same power, and the same mode of illumination, on a series of the increasingly larger forms, until the extremely coarse ones were reached. In this way the identity of the ultimate structure in every developmental condition would be seen.

The power necessary to resolve completely the smaller forms of the "*N. crassinervis*" in my cabinet was 800 diameters (obtained with the $\frac{1}{8}$th above referred to). The figure marked A, Plate CLXV., represents the result. The brilliant definition obtained by the lens, rendered much more apparent the "resolution" than the most delicate drawing or photograph could do; but the drawing given is a careful rendering of the *effect*. It will be seen that some portion of the striæ (transverse) are seen on the left-hand side of the midrib: but they are seen perfectly on the *right-hand side*; and in the upper half of it, resolution into *dots*, or hemispheres, placed in rectangular rows, is, in a good light, clearly visible.

Of course, it is not pretended that enumeration of striæ, and so forth, could be effected from this or the following drawings, as

from a photograph. But they accurately represent the general facts.

I next took a frustule of the same (reputed) form ("*N. crassinervis*") which was of an average size, and placed it under the same lens, with the same illumination. The result is given at B, which represents the frustule magnified as before—800 diameters. Precisely the same "resolution" is given; but faint longitudinal lines are seen, in addition to the far more plainly visible hemispheres, placed precisely as in A.

An average specimen of what was then labelled "*F. Saxonica*," was now made to replace the above, all the conditions remaining intact. The drawing C, magnified 800 diameters, represents the result. I have obtained more general "resolution" into hemispheres than is here shown; but the specimen is typical, and I preferred to retain it. Transverse striæ will be seen to be universal; longitudinal striæ are here and there faintly visible, and the rectangular rows of hemispheres are unmistakably manifest.

Finally, a fair specimen of what I had long known as *N. rhomboides* was placed on the stage of the instrument, and, everything remaining as before, was examined. The result — magnified as before—is given at D. What was now aimed at was not to get the largest surface of hemispheres, but to get such a general result as would show the exact correspondence, in ultimate structure, of the preceding forms with this. The transverse striæ, the longitudinal striæ, and the rectangularly placed rows of hemispheres, are all most distinctly seen.

But during the last three years some remarkable specimens of *Rhomboides* have come into my hands—specimens in which the frustules reach an immense proportional development; and in which the striæ, or rows of hemispheres, are very much coarser in relation to Mr. Hardman's coarsest frustules than the latter are in relation to the finest and smallest of the forms so recently called "*N. crassinervis*." The largest of these have been found by me in some mountings received from a friend, and marked as having come from "Cherryfield, America." The variation in their sizes, on the same slide, is very great, and the consequent difficulty of resolution; but I selected one of the larger forms, and employing the same illumination as in the instances given above, put on the $\frac{1}{4}$th immersion of Powell and Lealand (new formula) in place of the $\frac{1}{8}$th, and worked up to 600 diameters. The result is given at E, Plate CLXVI., which may be taken at once as the interpreter of all the rest, and the witness of their oneness. The striation in this case is everywhere resolved into rows of hemispheres, placed in rectangular order; and I know of few more beautiful objects in "still" microscopy than this. The frustule is of exquisitely perfect form, slightly tinted with yellow-brown: the hemispheres are everywhere

sharply and clearly separate, and the continuity of this is unbroken from end to end.

If this form be studied with a good $\frac{1}{4}$ (dry) of an angle of aperture of about 95°, and if the stage of the microscope be moderately thin, and all sub-stage gear be taken away, and the light from a good lamp condensed by a "bull's-eye" of about 5-inch focus be sent in at an angle of about 30° with the under surface of the slide, and the image of the flame be focussed on the centre of the object, this specimen of *Rhomboides* can be exquisitely resolved, on a black ground, with a third, or even a fourth eyepiece; the frustule itself, especially if seen amongst brilliantly white diatoms, assumes a pale sapphire tint, and the hemispheres with skilful management are beautifully developed.

Taking these facts together, then, and guided by the decision announced by Professor H. L. Smith and Mr. Kitton, we may safely conclude that *N. rhomboides* is a diatom very permanent in its general form and characteristics, but *extremely variable in its size, and the tenuity of the ultimate structure of its silicious frustules.*

But from this, a corollary inevitably follows. *N. rhomboides* is a most uncertain and unreliable *test.* Unless the same mounting, and in many instances the same frustule, be used, in testing the capacity of a given lens, the most incongruous issues may result. To be told that a certain glass will resolve "*N. rhomboides,*" may mean that it will resolve E, Plate CLXVI., or that it will resolve A, Plate CLXV.—quite a different result, and no guide as to whether A's or B's lens is better or worse than mine of the same power, unless the *same slide* of frustules be employed.

To those accustomed to the use and comparison of diatomaceous test-objects for practical purposes, this is no new inference, as Mr. Kitton has recently so profitably told us.* But it is so palpable an instance that it may carry conviction.

DESCRIPTION OF PLATES CLXV. AND CLXVI.

Fig. A.—*Navicula crassinervis* × 800 diameters, showing rectangularly placed hemispheres.

" B.—Ditto, ditto, a larger form similarly magnified.

" C.—*Frustulia Saxonica*, magnified by the same power, and showing similar structure.

" D.—A small form of *N. rhomboides*, also magnified 800 diameters, revealing the same structure.

" E.—A very large form of *N. rhomboides* from "*Cherryfield,*" America, showing a corresponding structure, with a magnification of 600 diameters.

* 'M. M. J.' vol. xiv. p. 45.

II.—*A Stage Incubator.* By H. A. Reeves, Assistant-Surgeon and Teacher of Practical Surgery, London Hospital.

(*Taken as read before the* Royal Microscopical Society, *December* 6, 1876.)

It is much to be desired that the various processes of elementary tissue change and of development and growth should be observed under the microscope. To this end I have devised the following simple apparatus, which, as will be seen, is a modification of the Stricker-Sanderson hot stage, with the gas-tubes omitted. The central cell, which is larger and ovoid, is only excavated to a depth sufficient to allow of a pigeon's, or smaller egg, as of sparrow, canary, &c., being admitted, and is continuous beneath the egg to permit of the circulation of the hot water. The accompanying woodcut, Fig. 1, represents a section of the incubator, the inter-

Fig. 1

rupted line being the cover-glass, and E the egg with its shell and fibrous covering removed sufficiently to expose the blastoderm. The space between the egg and the apparatus should be packed with cotton wool to retain the heat, and to prevent injury to the egg. If found necessary a little sulphuric acid can be dropped on the wool to prevent the condensation of vapour on the cover-glass. Page's gas regulator should be employed to keep the feeding water-containing vessel at a constant temperature, which can be watched by the attached thermometer. I hope that this simple instrument, permitting, as I believe it will, of the observation of the blastoderm, as an opaque object, for hours and days, may be of solid service in embryology.

It is obvious that by increasing the size of the instrument, a hen's or duck's egg could be accommodated; and if the excavation for the egg were carried quite through the centre of the incubator —but not at the sides—and enough of the shell removed from the *lower* side of the egg, I think the blastoderm and yolk could be

studied as transparent objects, provided a strong light and a good condenser were used.

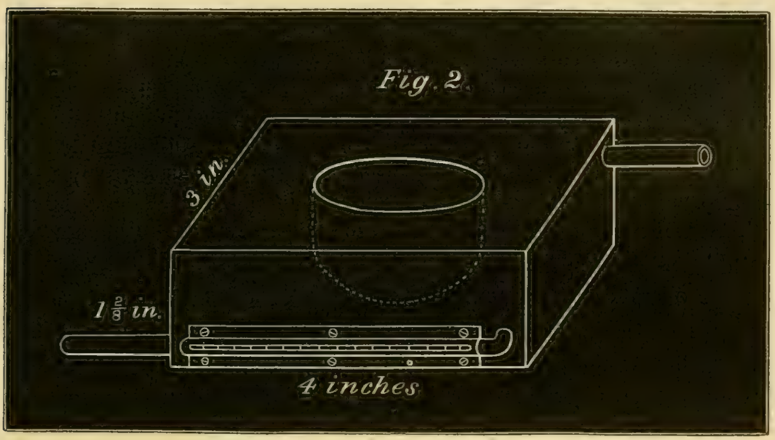


Fig. 2 represents the entire instrument, which is made by Mr. Hawkesley, of Oxford Street.

III.—*Notes on Pollen.* By Worthington G. Smith, F.L.S.

Plates CLXVII., CLXVIII., CLXIX., and CLXX.

The following notes on pollen have reference alone to the external form of a few typical pollen-grains as seen under the microscope. The formation of pollen within the mother-cells, the minute anatomical structure of pollen, and the nature of the pollen-tube, will not here be touched upon. A few words may be written on these latter subjects on another occasion.

The accompanying illustrations are all engraved direct from nature to one uniform scale; all the figures are enlarged 400 diameters. A mere glance will show how extremely pollen-grains differ in size, in form, and in external marking: they also differ greatly in colour, but from necessity on this occasion the colours cannot be conveniently reproduced. In nearly every instance the peculiar markings or reticulations on the cells are only partly indicated in these engravings (to save labour): for instance, in Fig. 5 the pattern is complete, whereas in 13 and 14 the peculiar markings are left unfinished for the reason mentioned. Pollen-grains also differ very much from each other in their viscidity or dryness of surface, and in their density or translucency. As a rule, pollen-grains are

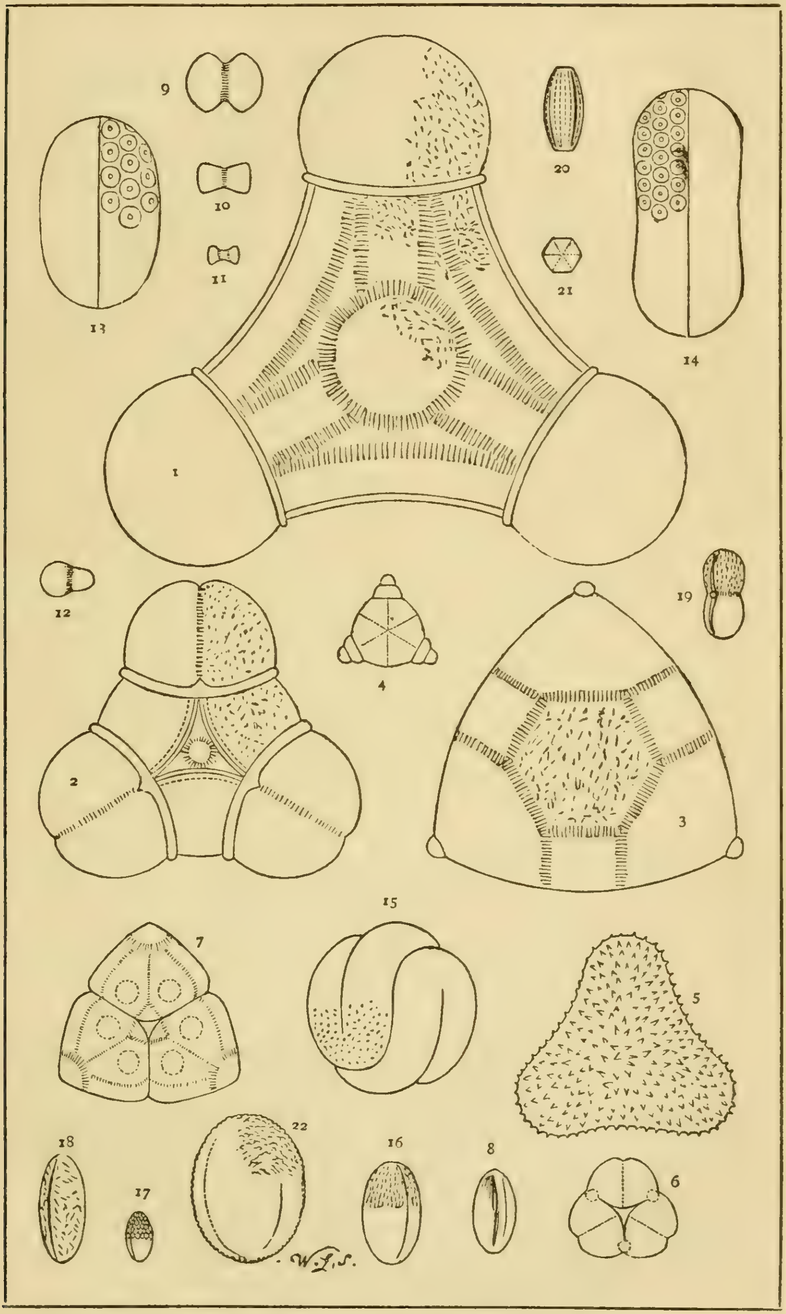
fairly constant in size and form in each botanical species of plant, but in long-cultivated garden varieties and hybrids the pollen shows a great tendency to vary.

The true form of pollen can only be seen when it is perfectly fresh and dry, at the time when it is naturally shed from the anther. If placed in water or glycerine for microscopical examination, the shape of the grain at once changes, commonly to a spherical form. Sometimes on drying the grain will return to its original shape, but more frequently it does not do so. A great number of Bauer's drawings, preserved in the herbarium of the British Museum, are taken from grains which have been immersed in fluid, and so the drawings cannot be implicitly depended upon.

Mr. A. W. Bennett suggests that plants may be roughly divided into two classes—the class which has the pollen carried to the stigma by the agency of the wind, and the class which receives the pollen through the agency of insects. The first class is said, as a rule, to have flowers without ornamental form or beauty of colour, and unfurnished with odours; the latter class is said to have bright coloured and more or less scented flowers, attractive to insects. The pollen-grain in the first class is said to be as a rule plain in form and easily carried by the wind; in the latter spiny or furnished with protuberances or furrows, to aid in its attachment to the limbs and bodies of insects. Generalizations are always dangerous, especially when made on a large scale, but in this instance Mr. Bennett's suggestion is undoubtedly supported by a large number of facts; there are, however, some striking exceptions.

It is never safe to judge of the character of pollen from a few grains shaken out of a corolla, as sometimes the interior of flowers will be found covered with pollen belonging to many different flowers. This is caused by the visits of flies, bees, and other insects, with pollen from various plants dusted over their bodies. Numerous natural hybrids arise from the visits of these pollen-dusted insects, and it is quite impossible to keep some garden varieties distinct on this very account. The ornamental Gourds of our gardens form a case in point.

In the genus Œnothera most of the pollens are large in size, and the grains are more or less attached to each other by fine viscid threads. The threads of necessity get entangled on the limbs of insects, and so the pollen is carried about and transferred in masses. One of the largest pollens known to us is that belonging to *Œnothera macrocarpa* (Fig. 1, Plate CLXVII.). A second member of the Onagrad family is illustrated in *Godetia Whitneyi*, in Fig. 2; whilst a third, *Clarkia pulchella*, is shown in Fig. 3. One of the smallest pollens seen by us in the Onagrad family is that belonging to *Circæa alpina* (Fig. 4). Associated with these pollens in the anther it is common to find groups of free crystals or raphides.



POLLEN GRAINS × 400. FIGS. 1 TO 22.

The four pollens just referred to may be considered quite typical of the Onagraceæ. The best marked species bear pollen which is most constant in form, whilst in the long-cultivated garden plants, as the Fuchsia, the pollen is always variable. When *Fuchsia procumbens* was reintroduced to our gardens a year or two ago by Mr. F. R. Kinghorn, it was expected that many beautiful and curious hybrids would be raised between this plant and some of the better known Fuchsias of our gardens; but we pointed out at one of the meetings of the Royal Horticultural Society that the pollen of *Fuchsia procumbens* differed from every other Fuchsia pollen known to us at that time.* Therefore the production of true hybrids appeared to us, if not impossible, at least very improbable. The statement of this fact was replied to by a famous horticulturist, who said hybrids had already been obtained, and so our hypothesis for a time fell to the ground. We waited for two years in doubt as to these hybrids, and last July we wrote to Mr. Kinghorn to know how they proceeded. In reply, Mr. Kinghorn immediately and frankly wrote: "I have not succeeded in raising any hybrids between *F. procumbens* and the garden sorts, although I have tried on a number with the greatest care." Elsewhere in the same letter Mr. Kinghorn remarked—"but I have succeeded in raising a few seedlings from *F. splendens* crossed with *F. procumbens*, really intermediate in character." Now in *F. splendens*, which is a good species, it is a singular fact that the pollen is of two forms; about one-third of the pollen is triangular in shape (like that of most Fuchsias), whilst at least two-thirds is so exactly like the peculiar-shaped pollen of *F. procumbens*, that it can hardly be distinguished from it.

Triangular pollens are by no means confined to the Onagraceæ family, as Fig. 5 represents the pollen of the common Honeysuckle, *Lonicera periclymenum*; Fig. 6 that of *Erica tetralix*; and Fig. 7 that of a Rhododendron, *R. Catawbiense*. Another member of the Erica family, *Clethra arborea*, Fig. 8, differs from the general form.

Few pollens are more interesting than those belonging to the Borage family. All we have seen are small, some quite minute, and all are more or less shaped like dumb-bells. Fig. 9 represents that of the common Comfrey, *Symphytum officinale*, Fig. 10 that of *Cerinthe bicolor*, Fig. 11 that of *Omphalodes linifolia*, and Fig. 12 that of *Echium vulgare*. The latter pollen is remarkable on account of its two lobes being always unequal, as shown.

Some members of the Acanthus family have beautiful pollen with peculiar markings. *Libonia floribunda* is represented at Fig. 13, and *Sericographis Ghiesbreghtiana* at Fig. 14. One of

* The pollen of *F. procumbens* is figured in 'Gardeners' Chronicle,' Sept. 5, 1874, p. 291.

the most peculiar and handsome of all pollens is found in Thunbergia, another member of the Acanthus family, *T. Harrisii*, shown in Fig. 15.

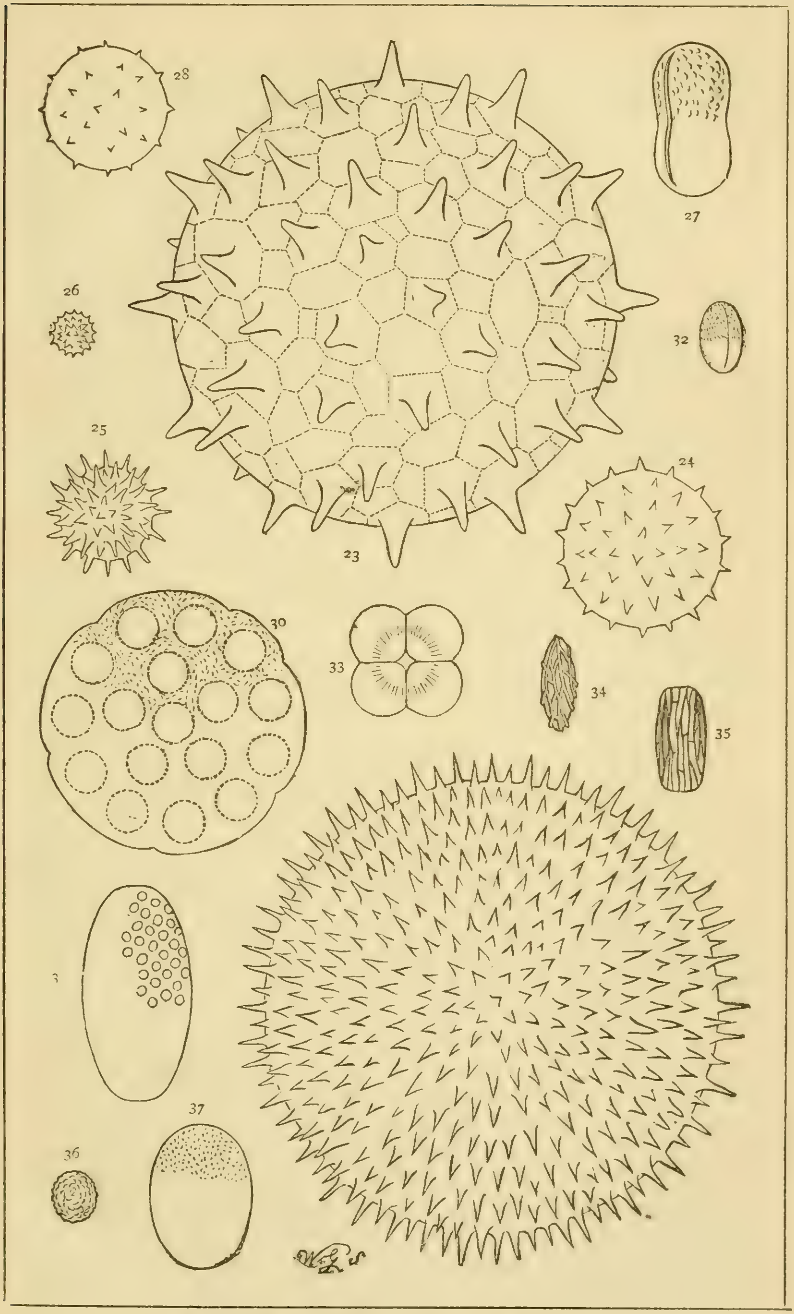
Turning now to the Scrophularia family, *Mimulus moschatus* is shown in Fig. 16. I have placed this figure exactly under the Thunbergia pollen, to call attention to the singular error made by Van Mohl, who, in one of his plates, figures the former pollen for the latter. I have also thus engraved the figures to show how errors are perpetuated, for Mohl's illustration of *Mimulus moschatus* is reproduced in the 'Micrographic Dictionary,' and in two other English works, without acknowledgment, and all wrong. The pollen of *M. moschatus* (a garden plant of long cultivation) is very variable. The pollen of one variety will be three times the size of another, or at times as big in size as the Thunbergia; but, though the same in size, it is always totally different in structure to an experienced eye. Still keeping to the Scrophularia family, Fig. 17 represents pollen of *Calceolaria Pavonii*, Fig. 18 that of the Foxglove, *Digitalis purpurea*, and Fig. 19 that of the Snapdragon, *Antirrhinum majus*.

Of the Euphorbia family, *Mercurialis annua* is illustrated in Fig. 20, *Xylophylla glaucescens* in Fig. 21, and *Croton pictus* in Fig. 22.

Some of the finest of all pollens are to be found in the Mallow family. Fig. 23, Plate CLXVIII., belongs to *Hibiscus rosa-sinensis*, and Fig. 24 to *Abutilon Darwinii*. All the pollens as seen by us in this family present the same characters. The common Hollyhock, and the two common Mallows, *M. sylvestris* and *M. rotundifolia*, have especially fine pollen.

Many members of the Composite family have spiny pollens; that of *Dahlia Cervantesii* is represented at Fig. 25, *Erigeron Canadensis* at Fig. 26, and *Centaurea cyanus* at Fig. 27. The latter, the pollen of Gazania, and of other members of the Composite family, considerably depart from the type, and, according as the plants approach or recede from the Dipsaceæ, the Valerianeæ, the Campanulaceæ, &c., so the pollens vary. Without doubt many valuable hints may yet be obtained from a careful examination of the fresh pollen of the Compositæ; sometimes the spines are very large. Mohl has represented the spines so thin as to be almost invisible in *Sonchus palustris;* and in the inaccurate, unacknowledged copies published in the 'Micrographic Dictionary' and in other English books, the spines are simply omitted altogether, so giving a very false impression of the real character of the Sonchus pollen.

The Canterbury Bell, *Campanula medium*, has echinulate pollen, as shown in Fig. 28. This pollen is a good general representative of the Campanula family.



POLLEN GRAINS × 400. FIGS. 23 TO 37.

We know no more beautiful pollen than that belonging to the major Convolvulus, *Ipomœa purpurea*, Fig. 29. *Convolvulus* (Calystegia) *soldanella* is shown at Fig. 30, and *Convolvulus arvensis* at Fig. 31. These three pollens, it will be seen, are very different from each other, and they ought undoubtedly to carry weight with those systematic botanists who are in doubt as to the natural position of the genera in the Convolvulus family. The Dodders (Cuscuta) are sometimes placed in the Convolvulus family, and the pollen of *Cuscuta trifolii*, Fig. 32, is certainly the same in character with Fig. 31, *Convolvulus arvensis.*

The different members of the Arum family furnish beautiful and most peculiar pollen-grains, of very diverse characters. Fig. 33 represents the pollen of *Phyllotænium mirabile*, Fig. 34 that of *Anthurium Patinii;* this latter is a most extraordinary pollen, marked with projecting longitudinal ribs. Fig. 35 represents that of *Spathophyllum heliconiæfolium*, 36 that of *Anthurium Scherzerianum*, and Fig. 37 that of *Richardia albo-maculata.*

The pollen-grains of the Lily family are very characteristic. Fig. 38, Plate CLXIX., belongs to *Lilium longiflorum*, and is remarkable for its large size and its bold and beautiful reticulations. Fig. 39 is that of *L. Californicum*, where the reticulations are very much smaller. Fig. 40 is that of *Aloe Abyssinica*, Fig. 41 shows that of *Narthecium ossifragum*, that of Fig. 42 *Convallaria majalis*, and Fig. 43 that of the Crown Imperial, *Fritillaria imperialis.*

Passing on to the Violet family, the pollen of the Heartsease, *Viola tricolor*, is engraved at Fig. 44, and that of the Sweet Violet, *V. odorata*, at Fig. 45. Though coming under the same genus, and possessing many characters in common, some species of Viola are far removed from each other in nature; the pollens, as will be seen in the engraving, are very different, and any hybridization between the two plants last referred to would appear to be quite hopeless, although a sweet-scented Heartsease is certainly a plant to be desired. In answer to a letter from us on this subject, Messrs. Dicksons and Co., of Waterloo Place, Edinburgh, a firm noted for the production of some of the very best hybrid Violas and Pansies now in the market, replied to us in the following terms: "We have tried to obtain a hybrid between *Viola odorata* and *V. tricolor*, but have never succeeded, and we never heard of anyone who had been more successful than ourselves."

Fig. 46 is the pollen of the tuberous Moschatel, *Adoxa moschatellina;* Fig. 47 that of the Snowberry, *Symphoricarpos parviflora;* and Fig. 48 that of the Elder, *Sambucus nigra.* As for the first, it is placed in Caprifoliaceæ both by Dr. Hooker and Mr. Bentham, in Araliaceæ by Prof. Babington, and in Saxifragaceæ by Linnæus and Jussieu. Unfortunately, very little is to be learned

from the pollen in this instance, for it agrees with the Caprifoliaceæ in its resemblance to Sambucus, Fig. 48 (but differs in the Snowberry, Fig. 47, and the Honeysuckle, Fig. 5); and it agrees with Araliaceæ in resembling the Ivy, Fig. 73, and with the Saxifrages in being very much like the typical pollens found in this genus. *Saxifraga umbrosa* (which is characteristic) is shown at Fig. 49.

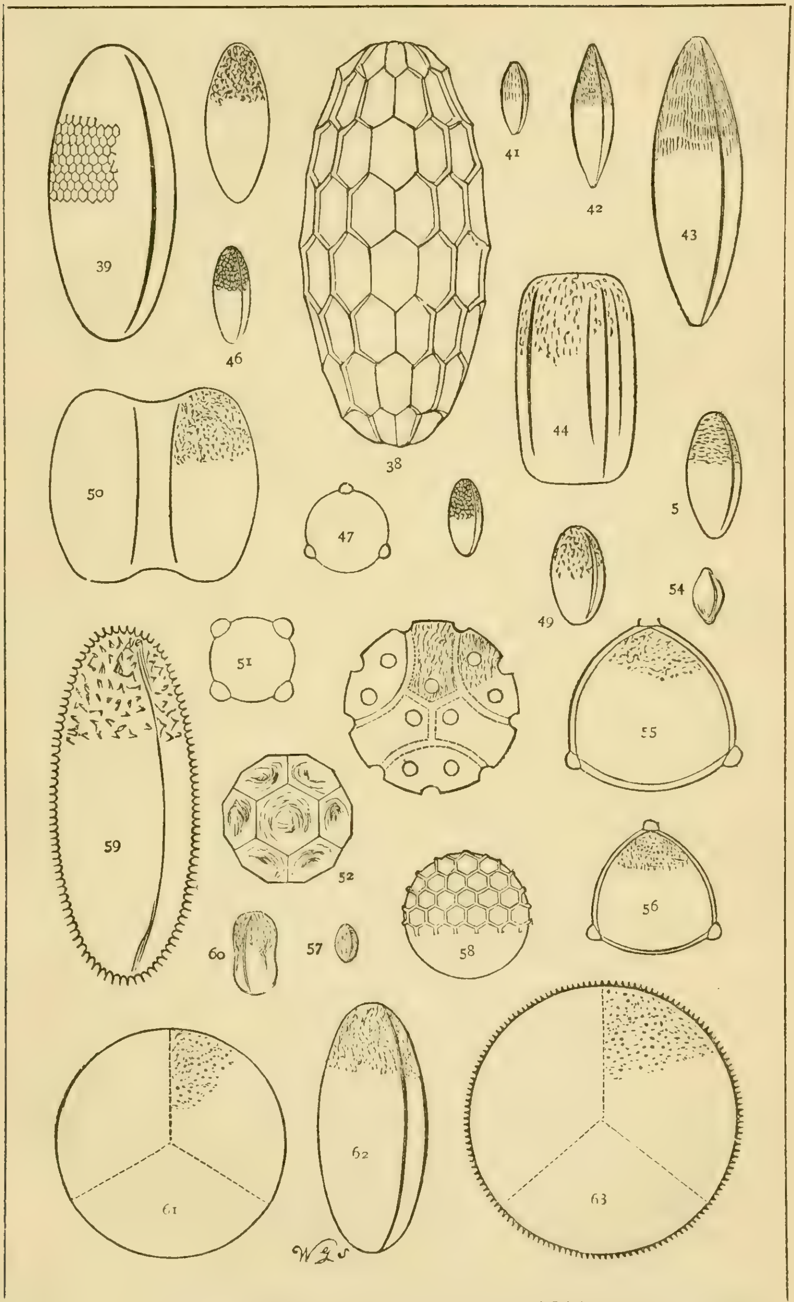
Fig. 50 belongs to the Cedar of Lebanon, *Cedrus Libani*, Fig. 51 to *Echeveria secunda*, Fig. 52 *Arundinaria falcata* (or, according to the 'Gardeners' Chronicle,' June 24, 1876, p. 826, the plant in view is more correctly named *Thamnocalamus Falconeri*), Fig. 53 *Passiflora cœlestina*, Fig. 54 the Nettle, *Urtica urens*.

Turning now to the Gourd family, the pollen of the Melon (*Cucumis melo*) is illustrated at Fig. 55, and the Cucumber (*C. sativus*), Fig. 56. Judging from the plants themselves, and the great similarity in the form and size of the pollen, it would appear quite possible to get a hybrid between the Melon and the Cucumber; and a well-known instance is on record of a supposed intermediate fruit produced naturally in Mr. Watson's nursery at St. Albans. For an illustration and description of this fruit, engraved by the writer, see 'Gardeners' Chronicle,' Oct. 4, 1873, p. 1335. The fruit was genuine, and was neither grafted or inarched, but whether or not it was a true hybrid, it certainly *was a natural growth from* the Cucumber plant. We believe the fruit illustrated damped off and rotted, and that no seeds were found inside. Before leaving the Gourds we may say the pollen of the Vegetable Marrow, *Cucurbita ovifera*, is totally different in character from the two last named, being two or three times larger in diameter, spherical in shape, and densely covered with spines. The Bryony of our hedges is again different from all three, but as large in size as the pollen of the Cucumber.

The common Bitter-sweet, *Solanum dulcamara*, bears very small pollen-grains, Fig. 57. The outline here engraved is a common form in the Solanum family.

The Polemonium family is remarkable for its truly handsome pollen, that belonging to *Phlox decussata* is illustrated at Fig. 58; *Cobæa scandens*, belonging to the same family, has a pollen about ten times the bulk of Phlox, and with similar elegant hexagonal reticulations.

Fig. 59 is a typical representative of the Amaryllis family in *Crinum pratense*, whilst Fig. 60 belongs to the common Snowdrop, *Galanthus nivalis*, and is the only departure from the typical form known to us in this family. Very little or nothing can be learned from a study of the pollens found in the genus Narcissus. The plants placed under this genus have been so often hybridized and have been so long cultivated, that the pollens (like the plants themselves) vary exceedingly. One anther belonging to a Narcissus will



POLLEN GRAINS × 400. Figs. 38 to 63.

commonly produce pollen-grains of the most diverse sizes. Fig. 59 (Crinum) is typical for shape, but many grains in Narcissus are linear, while others are triangular, and both these occur in the same anthers with typical grains.

These latter remarks hold good with the species and varieties of Iris as found in our gardens. Nothing can be made of the pollens of the mere garden forms, but that something may be learned from the study of the pollens of true species is shown by Fig. 61, which represents the pollen of *I. iberica*, and Fig. 62 the very differently formed pollen of *I. Kæmpferi*. These two forms, in good species of Iris, are both striking and constant. Gladiolus and Freesia have pollen similar in shape with Fig. 62. Fig. 63 belongs to *Crocus aureus*.

A great deal has been written as to possible hybrids between our wild Geraniums and our garden varieties, especially with a view to get a blue strain of colour into the garden plants. As far as we know, all these attempts have proved abortive; and from a study of the pollens in the Geranium family we are inclined to think that no such hydrids will ever be obtained. Fig. 64, Plate CLXX., is the pollen-grain belonging to our little wild *Geranium sanguineum*; *G. phæum* is the same in size, whilst *G. pratense* is much larger. On the other hand, Fig. 65 represents the pollen of *Pelargonium zonale*. In Mr. Turner's fine collection of Geraniums and Pelargoniums the pollens are very similar with the latter. In the genus Erodium the pollen-grains are globular. In Oxalis, Fig. 66, *O. acetosella*, and Tropæolum, Fig. 67, *T. majus*, the pollen-grains agree well with the Geranium family, and in this respect they add additional weight to the conclusions arrived at by Messrs. Hooker and Bentham, who place these two genera in the Geraniaceæ.

The pollen-grains of the Umbelliferæ are, as a rule, very characteristic. That of *Heracleum sphondylium* is shown at Fig. 68, *Œnanthe crocata* at Fig. 69, *Sium angustifolium* at Fig. 70. The curious genus Hydrocotyle has pollen similar with Fig. 71 in *H. bonariensis*, and with Fig. 72 in *H. nitidula*. The pollen of the common Ivy, *Hedera helix*, is shown at Fig. 73. Dr. Berthold Seemann proposed removing the genus Hydrocotyle from the Umbelliferæ to the Araliaceæ, but the characters of the pollen as seen in many genera and species of the two families hardly appear to us to support Dr. Seemann's views.

Fig. 74 is the pollen of the Bird's-foot Trefoil, *Lotus corniculatus*. This may be considered representative of the Leguminosæ. Fig. 75 belongs to *Cytisus laburnum*, whilst Fig. 76 is *Erythrina cristagalli*—a curious departure from the usual type.

Of the Labiate family, Fig. 77 belongs to *Nepeta violacea*, Fig. 78 to *Salvia patens*, and Fig. 79 to *Scutellaria Mocciniana*.

As far as our observation goes, these are the three salient and constant forms found in the Labiatæ.

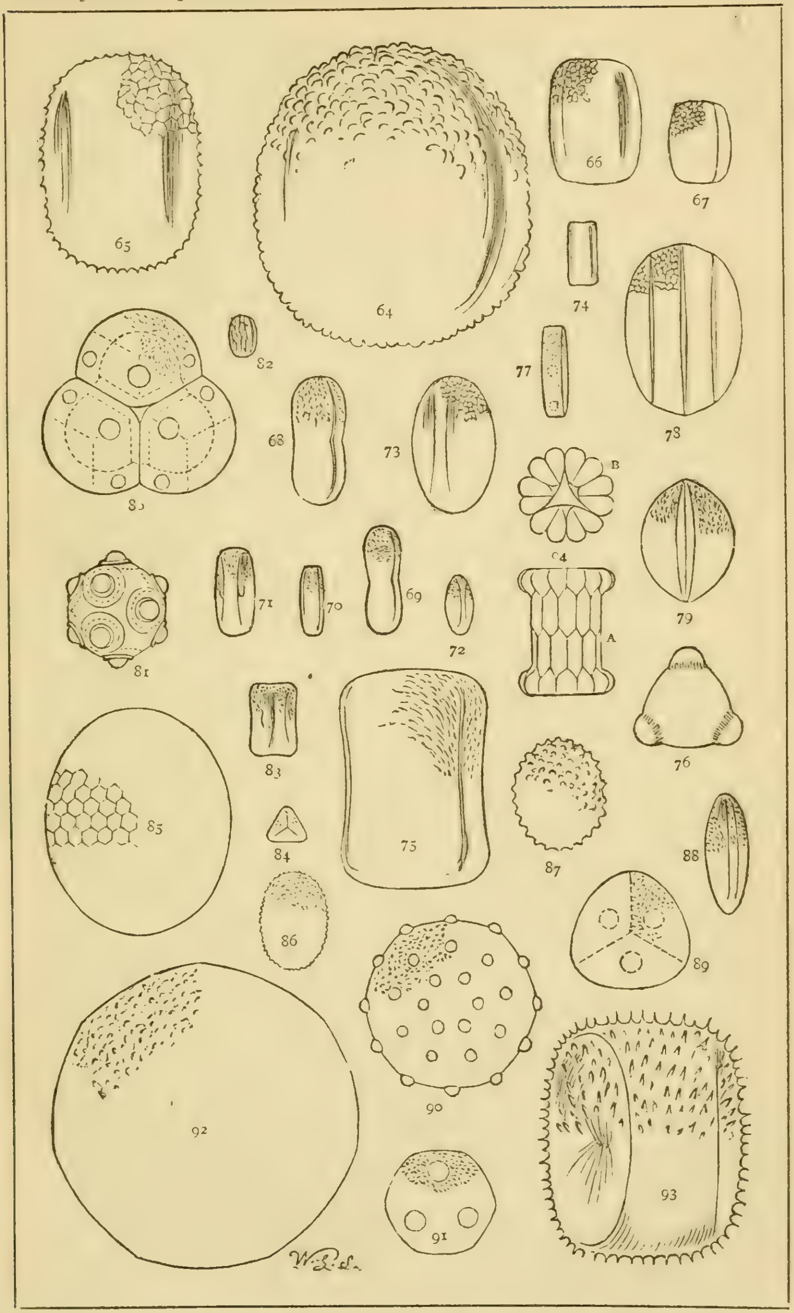
Fig. 80 is the pollen of *Epacris hyacinthiflora*, and Fig. 81 a highly ornamental pollen, belonging to *Fumaria officinalis*.

Turning now to the Primula family, *Primula viscosa* is illustrated in Fig. 82, *P. veris* in Fig. 83, and *P. denticulata* in Fig. 84. The latter is quite an exceptional form; the other two are characteristic of the family. The pollen of the common Primrose varies in size extremely, and the same fact holds good with the Cowslip and Polyanthus; in all three plants the pollen may at one time and place be eight times the bulk of what it is at a different place and in a different situation. Notwithstanding these variations, our *Primula vulgaris* is so different in its pollen from *P. japonica* that we consider the production of a true hybrid between the two plants to be very improbable. As far as our knowledge goes, no one has yet secured a true hybrid between *P. vulgaris* and *P. japonica*.

As an example of the pollens commonly found in the Plumbaginaceæ, Fig. 85 is given from *Armeria maritima*. Fig. 86 is from the Holly, *Ilex aquifolium;* Fig. 87 belongs to the white Water Lily, *Nymphæa alba;* Fig. 88 is a pollen-grain of *Papaver rhœas*, and is a good representation of the Poppy family. Fig. 89 is the pollen of the Lime, *Tilia Europæa*.

The pollens are all beautiful in the Pink family, Caryophyllaceæ. Fig. 90 represents the pollen of the Corn Cockle, *Agrostemma githago*, and Fig. 91 that of the Sweet William, *Dianthus barbatus*. In conclusion, Fig. 92 is engraved as a representative of the Cacteæ in *Opuntia polyantha*, the pollen-grains being flat disks and not spheres; and Fig. 93 is from the common Teasel, *Dipsacus sylvestris*. The last pollen illustrated, Fig. 94, is from *Polygala vulgaris;* two views are given of this pollen—one the side at A, the other the top at B: this is without doubt one of the most curious of all pollens. In the red, white, and purple varieties of *Polygala vulgaris* the pollen-grains also vary a little in form. At the exact time of maturity this pollen is perfectly spherical, but after it has fallen from the anther for about five minutes, or at most a quarter of an hour, it suddenly collapses into the shape here figured, and this shape it permanently retains unless the pollen be immersed in liquid.

We have thus hastily passed in review the external aspects presented by some of the pollens of the common plants of our fields, gardens, and greenhouses. Only a few families and about a hundred species of plants have been noticed, so that readers need not be reminded of how much there is still in the background in reference to the mere external form alone of pollen. Sometimes



POLLEN GRAINS × 400. FIGS. 64 TO 94.

pollen will give a valuable clue to a plant's relationships, whilst at other times it will give no clue at all, or it points in various contrary directions. This is because plants have not descended one from another in a straight line, but possess complicated relationships with plants belonging to several different natural orders. —*The Gardeners' Chronicle.*

IV.—*Microscopy at the American Exhibition.*

By R. H. Ward, M.D.

In briefly reviewing the microscopes exhibited at the American Centennial Exhibition, just closing at Philadelphia, it will be convenient to classify them in three more or less natural groups: the Continental, English, and American. All these classes are largely and characteristically represented by the most interesting and in many cases by the most distinguished examples of their kind, affording to microscopical students the best opportunity yet furnished in this country to study and compare the various types and qualities of tools available for their work.

It will be expedient to mention first, however, a few isolated and unclassifiable exhibits which are still of sufficient interest to demand a passing notice, such as a very small upright educational microscope of no well-marked character, from Switzerland; a small instrument from Tokio, Japan, which is evidently an early if not a first attempt, and a not unsuccessful one, though of unpretending form and crude workmanship, to imitate the instruments in vogue in this country a score of years ago; and a couple of large, clumsy instruments from Canada, one of them from Montreal and the other in the educational exhibit from Toronto, of which it can only be hoped that they do not fairly represent the science and art of our Canadian friends, since they are wholly devoid of any evidence of the spirit of that progress which has so fully and so fortunately changed the microscope from a piece of furniture to a tool for scientific work, and are in fact excellent illustrations of what a microscope ought not to be for educational purposes.

The Continental microscopes are chiefly represented by the exhibit of Nachet, of Paris, whose compact, ingenious, elaborate, and thoroughly built instruments are present in large numbers and great variety, constituting, with one exception perhaps, the most exhaustive exhibit in our department. Besides the familiar Nachet stands, large and small, monocular and binocular, for one observer and for more than one, and of course the inverted microscope of Professor J. L. Smith, which the manufacturer never should have

allowed to pass as his own, there are dainty pocket microscopes in cases of wood or nickel-plated metal, clinical, tank, and dissecting microscopes, and a few accessories, which, though not absolute novelties, are at least not usually seen on sale in this country. The most conspicuous and possibly the most worthless article in this exhibit is a huge inverted microscope, as big as a small stove-pipe, in which great amplification is gained by means of the great distance between the ocular and the objective.

Bardou and Son, of Paris, also exhibit, in connection with a large display of telescopes and other optical goods, one large instrument of the French style, having no important characteristics, and a few inferior instruments.

Austria is represented by S. Plossl and Co., of Vienna, whose little case contains a compact histological microscope of excellent design and attractive appearance. In place of a rack, a pair of arms attaches the body to the milled heads near their circumference, changing the rotary to a plunging motion, as if the driving wheel of a steam-engine moved the piston-rod, and giving a very delicate adjustment just as the body approaches a state of rest. Accompanying this instrument is a clinical one, of the German style, and far simpler than the French, English, or American forms.

The handsomest case of instruments in the English department, and indeed in the whole exhibition, is that contributed by the Ross house, of London. Less than this could hardly be true of a finely finished show-case well filled with their almost unequalled workmanship. With the exception of the new Wenham adaptation of the Jackson form of stand, and the series of new Wenham objectives which are understood to have been entered for competition and then permanently removed from the exhibition and the country, there is but little in the exhibit that would be called novel, most of the forms seen being the familiar and standard styles of several years past. No better commendation of the new stands, whose beauty is universally conceded, could be desired than is furnished by the old style Ross stands exhibited by their side. Notwithstanding the solid workmanship of the latter, and the care with which they were doubtless packed for transportation, the transverse bar which joins the body to the rack has in nearly every case given way under some unfortunate jar and become hopelessly though not conspicuously deformed. The untimely removal of the set of comparatively unfamiliar objectives from the exhibition could not have been an intentional breach of courtesy or propriety, but was certainly an unfortunate mistake on the part of both the proprietors who desired and the officials who permitted it.

R. and J. Beck's exhibit is perhaps the most complete in the exhibition, but is so badly displayed as to present a scarcely

attractive appearance. The large number of standard forms and the numerous and convenient accessories made by this firm have been so extensively exhibited and sold in this country that their peculiarities are well known. The chief novelties are a much-needed addition of centring and rotating adjustments to the sub-stage, and a showy introduction of aluminium mountings in some of the stands.

Henry Crouch, of London, also exhibits a full series of instruments characterized by a greatly improved quality of moderate-priced work, a class of work for which there is an increasing appreciation and a growing demand. His best stands of medium size lack scarcely any advantage as compared with far more clumsy and costly first-class stands. His variety of accessories is large and well selected, showing an earnest endeavour to adopt the best novelties from every source. His manufacture of a small histological instrument, with short body, low stage, and horse-shoe base, after the Continental method, is one more evidence of the growing favour with which such instruments are regarded in England and America, especially as it is sold at a price greatly disproportionate to its size and elegance.

Of Negretti and Zambra it need only be said that along with other goods they display a small variety of microscopes, of which but one, the largest, is notable, and that merely for its bigness. It belongs to the furniture style of instruments, and so does its large case of accessories. Precisely the same words may be applied, except as to numbers, to the two huge instruments of J. H. Dallmeyer, the smaller of which is, in the writer's judgment, too large for any known use.

The class of American instruments, though not as distinct a group as the other two, is mentioned separately for local reasons as well as on account of some peculiarities which its members have in common. Certainly first among these is the exhibit of Joseph Zentmayer, of Philadelphia, who offers the most elaborate and elegant instruments as well as the largest variety of different forms. His ingenious contrivances and excellent brasswork are too familiar to need description. He shows the large American, intermediate, hospital, and clinical stands, and the new student's, introduced a few years ago to meet the demand for histological instruments; also a material modification of the American, introduced this summer and known as the model, having the three new features of a fine adjustment by a long slide close behind the rack and moved by a screw and lever nearly in the Ross position, an interchangeable stage which can be almost instantly removed and replaced by an extremely thin diatom stage, and a bar, which carries the sub-stage and mirror, hinged at the level of the plane of the stage so as to enable the illuminating apparatus to revolve with

facility and in an easily measured position around the object as a centre. He also exhibits a new pocket microscope of neat and apparently serviceable construction.

T. H. McAllister's case, in the photographic building, exhibits his two or three grades of instruments, with chain movements, thin stages, and often iron bases, built with a view to both economy and excellence; and also a new-model physician's microscope, which is literally a charming little instrument, very portable and handsome, and combining with most of the excellences of the maker's former work the Zentmayer glass sliding stage and the diaphragm in the stage close to the object. The objectives furnished with it vary from fair to the best, according to the pecuniary views of the purchaser. The accessories are of the usual forms.

Bausch and Lomb, of Rochester, who have lately added to the province of the Vulcanite Optical Instrument Company, of that city, a microscopical department, under charge of E. Gundlach, formerly of Germany and late of Hackensack, N.J., exhibit a large series of entirely new designs. These are all of excellent workmanship, though of low or medium grade as to size, complexity, and cost. By simplifying the designs, introducing vulcanite into the mountings where it can be done to advantage, and introducing the business principle of attempting to create a large demand by production at a very low cost, the experiment of offering good instruments at a very low rate is being tried on a scale and with facilities unprecedented in this country. The special peculiarities of these stands, aside from the vulcanite mountings, are the hinging of the sub-stage bar at the level of the object, contesting in this respect the priority with Zentmayer's new stand; a new object carrier, which with some improvements may be convenient; a new fine adjustment, by means of a screw acting on the body, which is supported at the end of two parallel horizontal springs, which allow a peculiarly smooth motion practically incapable of deterioration from wear or any other probable cause; and a coarse adjustment, consisting of a slide at the upper part of its course, and, below, a rapid screw which prevents pushing the body suddenly through the slide, and, without interfering with a prompt adjustment of low powers by sliding, gives a delicate adjustment for higher powers by screwing. This method is evidently a modification of Wale's oblique slot.

George Wale's new student's microscope is exhibited by the Stevens Institute of Technology. This is indeed an educational microscope, and not a burlesque on the claim of the instrument to educational value. It is a small and compact stand, of the Continental style, with horse-shoe base and low stage, of most substantial workmanship, adopting the Zentmayer glass stage, and introducing an original coarse adjustment by means of a sliding

tube with the addition of a pin moving in an oblique slot and giving a rapid and very steady and safe adjustment by means of a screwing movement, and an iris diaphragm capable of being used after the Continental plan close to the object slide, consisting of a thin split tube whose blades are overlapped and gradually closed by being screwed up into a dome-shaped cavity in the bottom of the stage plate. The instrument is furnished with Wale's excellent lenses.

James W. Queen and Co. exhibit their instruments, which are of the English type, reduced and adapted to the student's microscope grade, and aim rather to combine well-known excellences into a good and popular instrument, than to introduce novelties of construction.

The instruments by W. Y. McAllister, in the Pennsylvania State Educational Exhibit, do not seem to suggest any of the progress of recent years.

A set of William Wale's exquisite lenses was exhibited by Mr. Zentmayer, but was unfortunately allowed to be prematurely removed from the case.

Several makers are conspicuous by their absence. All visitors to this department would have been glad to see Hartnack, and Powell and Lealand, and the German makers, well represented; and many felt disappointed at the absence of Spencer, of Tolles, and of Grunow, having very reasonably expected that such prominent American makers would, from motives of fitness and courtesy, if not of interest, contribute their share to the completeness of the International Exhibition. It would have been peculiarly appropriate, in view of their undisputed excellence and their high claims, that the new duplex-front objectives of Tolles should have been placed in comparison with the world's other lenses, while the unhandsome insinuation which is being extensively printed in advertisements, that they are not at the exhibition because they would not be properly examined there, must have been authorized without serious thought by the persons responsible for it. It is well known that President F. A. P. Barnard, who was associated with such judges in this group as Professors Joseph Henry, J. E. Hilgard, and others scarcely less distinguished, gave his personal attention to the examination of the exhibits in this department.

Among the objects, other than microscopes, of special interest to microscopists, may be classed the double-stained vegetable preparations by Dr. Beatty, the large series of fine mounted objects by W. H. Walmsley, and the far from equal set of imported objects, both exhibited by James W. Queen and Co., and the more limited series of pathological specimens, by Dr. H. N. Krasinski, in the Russian department; the already famous machine for micro-ruling

on glass, by Professor Rogers; the hitherto unequalled photo-micrographs, by Dr. J. J. Woodward, exhibited by the Army Medical Museum, and the good though less pretending attempts in the same direction, by Dr. Carl Seiler, in the photographic building; and the large, interesting, and carefully prepared series of minute fungi, with tinted drawings of the same, contributed by Mr. Thomas Taylor to the exhibit of the department of agriculture in that most creditable portion of the whole exhibition, the United States Government Building.—*American Naturalist*, December 1876.

NEW BOOKS, WITH SHORT NOTICES.

The Fungus Disease of India : a Report of Observations. By T. R. Lewis, M.B., and D. D. Cunningham, M.B., Special Assistants to the Sanitary Commissioners of the Government of India. Calcutta: Government Printing Office.—As to the important question whether this disease—which is not uncommon in India—is caused by the growth of a peculiar fungus, the *Chionyphe Carteri*, or not, the present work is intended to decide. It is in point of diction a clear, readable account of the evidence pro and con on the point, and it moreover contains an abundance of very admirable illustrations (some of them coloured), both of the appearance of the limb in its unmagnified state and of the different forms that are observed when high powers are employed. And what is the result arrived at by the two thoroughly competent observers whose labours we have now before us? It is this, that the so-called fungus-foot of India is not a disease produced or promoted by the growth or development of any species of fungus whatever. And what are the arguments in favour of this view of the matter? They are two or three. In the first place the nature of the roe-like bodies of pink and black masses has been made out to a certain extent. At all events, it is shown that they are not in any shape or form a fungus growth. On the contrary, the investigations made into the matter have shown that the first of the peculiar morbid products is simply "fat in various modified forms." The second did not display "the slightest trace of a fungus or of other vegetable organisms" in its constitution; and the third consists "of degenerated tissue mixed to a greater or less extent with black pigment and fungoid filaments." Now, fungoid elements have refused to grow when an attempt to cultivate them has been made. Therefore the authors think there is no need taking them into consideration. But what do they give us in their stead? On this point it must be confessed the book is particularly barren. It is true they cite two or three experiments which we confess do not prove very much, and then they go on to conclude that "taking everything into consideration, it seems probable to us that some local degeneration takes place in the madura-disease giving rise to a product which is in one of its varieties peculiarly adapted to the development of vegetable organisms." From which it appears to us that it would have been better for the authors to have withheld the publication of their researches till they had more positive evidence and less speculative fancies to give us on such an important subject as this one undoubtedly is.

PROGRESS OF MICROSCOPICAL SCIENCE.

Observations on Rhizopods.—Some investigations have been recently conducted on Rhizopods by Professor Leidy, who stated to the Philadelphia Academy, that last July, in the sphagnum swamps of Tobyhanna, Pocono Mt., Monroe Co., Pa., he noticed an abundance of a Rhizopod which he thought he had not previously seen, and which he at first supposed to be an undescribed species, but which he now viewed as a variety of *Hyalosphenia ligata.* From this, as previously described, it differs in the test being of a pale sienna colour, and perhaps of greater thickness, but otherwise is like it. The test is compressed pyriform, with the length and breadth nearly or about equal, and the thickness one-half. The lateral borders are obtusely rounded. The mouth is transversely oval. The sarcode is colourless, and attached to the inside of the test by diverging threads. The pseudopods are usually from two to three. Measurements ·08 mm. long and broad, and ·036 thick, with the mouth ·02 broad and ·008 wide. Others varied from ·06 long and ·08 broad, to ·092 long by ·064 broad. In observing the Pocono variety of *Hyalosphenia ligata*, and the beautiful and well-marked species *Hyalosphenia papilio*, he detected an important point of structure which previously had escaped his notice. In the active condition of these, and other Difflugians, they are seen with one or more pseudopods extended from the mouth of the test, to the margin of which the sarcode is attached, as well as by diverging threads to various points of the interior of the test. The interval between the body of the sarcode and the interior of the test is occupied with water. The extent of the interval increases with the increase in number and extent of protrusion of the pseudopods, and also varies according to the degree of emptiness or repletion with food of the sarcode body. When the pseudopods are withdrawn into the mouth of the test, the mass of the sarcode expands in a corresponding ratio, and the threads of attachment to the inside of the test contract in length. The intervening water appears to be displaced through small apertures of the lateral borders and fundus of the test, which exist in numbers usually from two to half a dozen or more.

The Early Development of the Mammalian Embryo.—Mr. E. A. Schäfer, of University College, has contributed a valuable paper on this subject to the 'Proceedings of the Royal Society' (No. 168); and we much regret that our notice of it has been so long "crushed out." The paper is upon only the early stages of development; but those who know anything of the subject of development are aware how very incomplete is our actual knowledge on these points. Mr. Schäfer noticed these ova in the *cornua uteri* of a cat which had been just killed. He observed five swellings in the *cornua*, and an equal number of *corpora lutei* in the ovaries; therefore he concluded that these swellings were ova. So removing the uterus, and placing it in a weak solution of bichromate of potash, he proceeded carefully to slit open the cornua under the fluid with fine scissors. As each one of the

above-mentioned dilatations was reached, a minute, beautifully clear, vesicular body floated out into the surrounding liquid; there was no sign of any adhesion to the uterine wall. He then goes on to say:—

"The vesicles were as nearly as possible similar in size and appearance, and a description of any one of them will serve for all. Their shape was oval, the long diameter measuring about $\frac{1}{7}$ inch, the short about $\frac{1}{15}$ inch, and the outline being perfectly smooth and even. Under a low power of the microscope, the vesicle was distinctly seen to be bounded by a primitive chorion or thinned-out zona pellucida. No trace of villi or projections of any sort could be detected on its surface. Besides this envelope, the wall of the vesicle was composed of what appeared a simple layer of flattened polygonal cells, closely lining the zona. But under a somewhat higher power a stratum of more deeply lying cells could, in some parts at least, be detected by focussing; moreover, a shadow at one place, midway between the poles of the oval, appeared to point to the possibility of the existence of a slight thickening at this part, although a well-defined *shaded* area was, in no sense of the word, visible.

"I was led to imagine that the 'shadow' in question, or rather the thickening to which it was probably due, would be caused by the first beginnings of a mesoblast at this situation. But nothing more could be made out in the fresh condition, and the little vesicles (at least two of them, for the others were of less value for the purpose of sections, owing to the blastoderm having shrunk away at various places from the zona, and presenting a crumpled, distorted aspect) were accordingly hardened in the usual way in very dilute chromic acid, stained with logwood and with carmine respectively, imbedded by the gum-process,* with the object of filling the cavity and thus supporting the enclosing parts and preserving them in their natural positions; and finally sections were made across the long axis of the oval, and were mounted in glycerine and examined.

"A glance at the sections is sufficient to show that the blastodermic vesicle is in the bilaminar condition. There exist within the zona pellucida, or primitive chorion, two distinct layers, the section of each forming a complete circle; the whole structure, therefore, included by the zona being formed of two separate vesicles, one within the other. The outer of these is of course the epiblast, the inner doubtless representing the hypoblast; we may speak, then, of an epiblastic and a hypoblastic vesicle. In none of the sections was there any trace of an intermediate layer of cells or mesoblast. The epiblast closely lines the zona throughout; but the hypoblastic vesicle is considerably smaller, so that except at one part, where it comes into closer proximity than elsewhere with the epiblast, it is separated from the latter by a considerable interval, filled in the fresh condition by a clear fluid. This fluid would seem to be of a different nature from that which occupied the cavity of the hypoblastic vesicle, for the coagulum produced in it by the action of the hardening liquid has a

* A bad method for embryos; but I was at the time ignorant of Kleinenberg's excellent plan for effecting the same object. See Forster and Balfour, 'Elements of Embryology,' p. 249.

much more granular appearance in the sections. Both epiblast and hypoblast throughout almost the whole extent are composed of a simple layer of flattened cells joined edge to edge. Most of the epiblastic cells exhibit in a high degree a condition of the nucleus which is frequently met with in epithelial cells elsewhere—a tendency, namely, to become separated into a clear colourless part, and a highly refracting and usually somewhat irregular body, which readily becomes stained by the usual colouring reagents. This change is no doubt a post-mortem effect, probably produced by the action of the reagents employed. The hypoblastic cells do not for the most part present this appearance; their nucleus remains large, round, and clear; and the cell-substance does not become stained as much as that of the epiblastic cells.

"It was mentioned above that the epiblastic and hypoblastic vesicles come into closer proximity at one part of the circumference than elsewhere; even here, however, they do not come into actual contact. At this place they are no longer formed, as elsewhere, of a single layer of cells; but their component elements, besides being rounder in shape and smaller, are two or three deep, although not arranged in as many definite strata. Both layers are in consequence somewhat thickened just here, the thickening (which is most marked in the epiblastic vesicle) extending over an area of about $\frac{1}{60}$ inch in diameter; not sharply defined, however, but gradually shading off into the thin part. Both epiblast and hypoblast are, it may be repeated, perfectly well defined and distinct from one another here as elsewhere; and there are no cells to be seen which do not clearly belong to one or the other. Moreover, they are not only separated by a small but obvious amount of the granular material (coagulated fluid) previously mentioned, but there is in addition an exquisitely fine pellicle, which in the sections appears as a mere line passing over and forming a definite boundary to the upper (outer) surface of the hypoblast at the thickened area. This membranous pellicle, for which I would venture to propose the name of *membrana limitans hypoblastica*, is, as made out in teased preparations, perfectly homogeneous, and continues so throughout its extent. It becomes stained slightly by carmine, but apparently not at all by logwood, and is probably to be looked upon as a cuticular formation produced by the hypoblastic cells. Whether the delicate pellicle may extend around the whole hypoblast in the natural condition, I am unable to say; in the sections, at any rate, it appears to terminate towards the periphery of the thickened area, and to have become curled somewhat away from the hypoblast.

"I am not aware that a similar structure has yet been noticed in the early blastoderm of any animal; but its importance in this case in bounding the hypoblast is evident. Indeed, if it should be found that the membrane in question is of general occurrence in the mammalian germ, and that the first appearance of the mesoblastic cells occurs external to it, as from its proximity to the hypoblast there is little reason to doubt, the fact of the existence of such a film between the commencing mesoblast and hypoblast is strongly in favour of the

view which derives the former from cells of the epiblast, as against that which would assign to it a hypoblastic origin."

In conclusion, it may be observed that Mr. Schäfer finds that Hensen has also observed this structure.

The different Sexuality of Volvox globator and V. minor.—This important subject has been investigated by M. L. F. Henneguy, who read a paper before the French Academy in July last. This paper is abstracted at some length by the 'Academy.' It states that M. Henneguy describes *Volvox minor* as dioicous, while the *V. globator* is monoicous; and its reproduction has been recently described by Cohn.* The dioicous volvox is a colony of unicellular algæ, each member being furnished with two vibratile cilia, and all disposed regularly in the gelatinous wall of a hollow sphere. M. Henneguy finds four kinds of these colonies, which he calls *cœnobiums:* 1, containing only vegetative cells, and having young cœnobiums in their interiors, each derived by division and multiplication of a vegetative cellule; 2, a great number of these cœnobiums which contain, likewise, male elements, *androgonidia*, situated in the thickness of the gelatinous wall; 3, those which exhibit only vegetative cells and androgonidia, and not producing any daughter colonies; 4, female cœnobiums which contain only *gynogonidia*, or oospheres in the interior of their spheres. The androgonidia are formed at the expense of a vegetative cell which acquires a larger volume than the rest, and divides into parallel segments, each having the form of an elongated cone with its thickest end green, and the other one transparent with a little red point, and two vibratile cilia. The bundle of antherozoids exhibits a continual oscillation in the antheridium. The gynogonidia spring likewise from a differentiation of a vegetative cellule, which grows much larger than the androgonidia, and becomes full of starch and chlorophyll granules, giving the oospheres a dark-green aspect. At the moment of fecundation the bundles of antherozoids are set at liberty by the dissolution of the antheridia wall; they move quickly through the water, and fix themselves on the female cœnobiums, and then separate to fecundate the oospheres, but the author was not able to observe the exact moment of their penetration. After fecundation, the oospheres surround themselves with a thick membrane having a double outline, which was not previously visible, and rapidly change colour, passing from dark green to yellow green, and then to orange. They then contain a red oily matter and a larger quantity of starch. This orange coloration made some observers suppose it was a separate species, the *V. aureus*, Ehr. These volvocina, male, female, and neuter, seek the light and keep near the surface of the water; but when the female colonies are fecundated they get away from the surface. In a glass vessel the green ones will be seen on the side of the light: the others on the opposite side. If the vessel is turned round they change places, and the orange ones fly from the light quicker than the green ones seek it. When these objects first appear in the waters where they are formed, scarcely any but neuter colonies

* 'Beiträge zur Biologie der Pflanzen,' 1875.

are seen—that is to say, only those which give rise by segmentation to daughter colonies. After a little time the number of colonies contained in each cœnobium diminishes, and then a great number appear with the androgonidia, which represent aborted daughter colonies. At this moment we find a few female groups not containing daughter colonies. After reproduction has gone on for some time by means of daughter colonies, we observe the number of female cœnobiums augment, and some composed exclusively of males appear, while the neuter sorts become very rare. M. Henneguy compares these facts with what occurs among plant-lice, which degenerate after the parthenogetic production has gone on for some time, and their digestive and generative organs tend to atrophy. Males are then produced, and, subsequently, females requiring fecundation.

The Embryology of Cucumaria doliolum.—This has been described by Professor Selenka as follows:—After the formation of the single-layered blastoderm, and the embryo breaks through the egg-skin, it swims freely by means of its ciliated membrane. As the flagella gradually disappear, its activity is reduced to a backward and forward motion, and when the tentacles are protruded it sinks to the ground, and moves only by crawling. After fecundation the nucleus (*Kern*) diminishes, and becomes a mere drop of protoplasm, inside which a germinal speck (*Kernhof*) appears in an hour or two. The segmentation of the yelk goes on till 250 cylindrical flagellate cells are formed. "When the embryo emerges from the egg and swims in the open water it contracts itself in about twelve hours to about one-fifth of its diameter. Hereupon from its hinder pole, and below a flattening of the same, three to eight blastoderm cells project inwards. The endoderm is formed by cells springing from the flattened pole of the blastoderm, which rapidly multiply by fission. The mother-cells of the mesoderm remain in their original position, while the daughter-cells, as amœboid bodies, or motile cells, move about in the yelk, till at last the segmentary cavity (*Furchingshöhle*) appears like a loose aggregate of stellate cells." The author describes the formation of what he terms the primitive intestine (*Urdarm*) (which begins with an unfolding of the aboral pole), the commencement of the water-vascular system, and other matters which could not be explained without translating his paper in full.

The Structure of the Common Mushroom.—This has been explained very fully by Mr. Worthington Smith, F.L.S., in a paper which he read before the Cryptogamic Society of Scotland (September 26), and which was illustrated by numerous drawings. He says "that the entire substance of the common mushroom is made up of excessively small bladder-like cells; these cells are so small in size and light of weight, that no less than 1,500,000,000,000 (one and a half billion) of cells go to every ounce of the mushroom's weight. Mushrooms are generally grown by dealers from spawn or mycelium; this spawn is nothing but living matted cells in a resting condition, needing warmth, moisture, and darkness only for vivification. Mushrooms may, however, be grown from the purple-black dust which falls from their

lower surface. This black dust again simply consists of nothing but cells, but in this case the cells are termed spores. These latter are of a somewhat different nature from the simple cells of the flesh of the mushroom, and their outer coat in this species is changed in colour from transparent to purple-black, possibly from contact with the air. The cells in the stem of the mushroom are sausage-shaped, and grow vertically; on reaching the cap these cells spread over in an umbrella fashion, and descend into the internal substance of each individual gill. This internal mass of cells within the gill is termed the 'trama' by botanists. To understand how the mushroom produces its seeds or spores, a slice should be cut off the side of the cap of a mushroom from the top downwards. Where the sectional part is now exposed, the gills which are cut through will look like so many small fine teeth of a comb. With a sharp lancet a very small thin transparent fragment must now be sliced off from the top downwards, and placed upon a glass for examination under the microscope. When magnified 250 diameters this fragment will be seen to consist wholly of simple cells. These 'trama' cells are of some importance, because certain members of the mushroom tribe have no larger cells of this nature. As these latter cells gradually grow to the exposed surface on each side of the gill, they get considerably smaller in size, denser, and less and less transparent. The exposed surface of the gill is the fruiting, spore-bearing, or hymenial surface. The spores in all the mushroom tribe are produced in clusters of four on each basidium, but on the common mushroom and all its varieties, as far as I have seen, these four spores are generally produced two at a time, and as the first two drop off the last two appear, so that it is seldom that more than two are seen *in situ* at the same time. This phenomenon teaches a valuable lesson, and one which has, as I conceive, been quite erroneously interpreted by Professor Sachs,* who says the common mushroom only produces two spores on each basidium, and so illustrates the subject in his fig. 174. The cells of the mushroom increase in number by apical growth. The last-formed cell repeats the process continuously till the fungus is complete and the special cells (spores) destined for the reproduction of the species are reached. The basidium is first a simple cell, seen in two positions. This simple cell becomes potentially (but often indefinitely) divided by a *longitudinal* partition; each of these divided portions produces a branch, and each of these branches bears a spore, which in its turn is again cut off by cell division, this time *transversely*. The basidium is now again *longitudinally* divided; these portions in their turn also produce new branches, which give rise to two more spores, each spore again cut off by a *transverse* septum. As the two last-formed spores increase in size they gradually push the two old ones off their supports, so that unless the whole process is very carefully watched it might be concluded that the mushroom produces only two spores (instead of four) on each basidium, as stated by Professor Sachs.

"The mature spores on germination of course reproduce the species

* 'Handbook,' p. 251.

by means of a series of new cells. All experiments prove the life of the spore to be very short, but when the spore once germinates and forms spawn the latter material has great tenacity of life, and this mycelium is commonly, if not always, perennial."

American Work with the Microscope.—We have been furnished by Mr. A. S. Packard with a valuable sketch of the work that has been done with the microscope in America. This, however, has only to do with zoological progress; and great though it undoubtedly is, we cannot agree with the author in his assertion* that it is vastly superior to the labours during the same time of those who worked at the same subjects in either France or England. The following is part of Mr. Packard's paper, which includes all the American labours in zoology:—
"The epoch of embryology or the developmental study of animals was inaugurated by Agassiz in 1846. In the publication of his 'Contributions to the Natural History of the United States,' mainly devoted to the developmental history of the radiates and turtles, Agassiz was assisted by H. J. Clark, who, under his training, became the best histologist our country has yet produced. W. J. Burnett, another histologist, was only inferior to Clark. Macrady, another of Agassiz's students, published some papers of importance on the Acalephs and their mode of development. Desor and Girard wrote on the embryology of worms. Memoirs of a high order of merit followed, from the pen and pencil of Mr. Alexander Agassiz. His embryology of the Echinoderms appeared between 1864 and 1874; the memoir on the alternation of generations of the worm, *Autolycus*, appeared in 1862; his paper on the early stages of Annelids in 1866; his remarkable memoir on the transformation of *Tornaria* into *Balanoglossus* was published in 1873; and his elaborate embryology of the Ctenophores in 1874. In 1864, Jeffries Wyman, at the time of his death our leading American comparative anatomist and physiologist, published a memoir on the development of the skate. The beautiful memoir of Hyatt on the embryology of Ammonites was a difficult research, while the brilliant papers of Morse on the early stages of the Brachiopod, *Terebratulina*, published in 1869–73, enabled him, by embryological as well as anatomical evidence, to transfer the Brachiopods from the Mollusca to the vicinity of the Annelidan worms. His studies on the carpus and tarsus of embryo birds should also be mentioned. In 1872 Packard published a memoir on the development of Limulus, and pointed out the affinities of its young to certain young Trilobites; and he also published papers on the embryology of the Thysanourous, Neuropterous, Coleopterous, and Hymenopterous insects. S. I. Smith traced the metamorphoses of certain crabs and shrimps. Several entomologists, as Harris, L. Agassiz, Fitch, Riley, Scudder, Packard, LeBaron, Hagen, Cabot, Walsh, Saunders, Edwards, and others, have studied the metamorphoses of insects, while the drawings in illustration of Abbot and Smith's 'Natural History of the Rarer Insects of Georgia' were made by Abbot, who lived several years in Georgia. In 1874 Emerton described the embryology of the spider, *Pholcus*, and during the present year an

American Naturalist,' October.

important memoir by W. K. Brooks on the anomalous mode of development of *Salpa*, a Tunicate, has appeared." We may observe, in conclusion, that Mr. Packard's own labours have not been surpassed by any of those he has mentioned; and though his modesty as the writer of the paper prevented any notice of himself, we must take this opportunity of recording the fact of his being one of the first comparative anatomists in the United States.

The Examination of Muscular Fibres.—The 'American Naturalist' (October) publishes a note, in which a mode of double staining these structures is described. It is as follows:—Dr. Geo. D. Beatty calls attention to the *Lissotriton punctatus* (the smooth-skin newt) and the *Amphiuma tridactylum* as microscopical treasures, the muscular fibres, especially of the tongue, being particularly beautiful, the transverse striæ being very well marked, and the nuclei very large in both species, and greatly elongated in *Amphiuma*, stretching one-third across the field with a $\frac{1}{5}$th objective and A ocular. The tissues should be double, stained for the nuclei with carmine and with picric acid to bring out the transverse striæ. The tissue is hardened by 95 per cent. alcohol, followed by absolute alcohol, and sections cut in a section machine or fibres teased out carefully with needles. The sections or threads are placed for one minute in 25 per cent. alcohol, soaked for five minutes in Dr. J. J. Woodward's borax-carmine solution, soaked about ten minutes in alcohol acidulated with 20 per cent. of hydrochloric acid until the carmine is nearly removed from all parts except the nuclei, washed in alcohol for a few minutes, the solution being changed until free from acid; then placed for one-half to one minute in an alcoholic solution, one-twelfth grain to one ounce of picric acid, washed in alcohol, and transferred through absolute alcohol and oil of cloves to balsam for mounting.

The Matrix of Articular Cartilage.—Mr. H. A. Reeves writes from the London Hospital to the 'British Medical Journal' (November 11) as follows. He says that having "for some months past been engaged in the study of joints, I have had occasion to apply various methods, too numerous to mention here; but I wish to bring under the notice of histologists some means by which the demonstration of the structure of so-called hyaline cartilage may readily be accomplished. The perusal of Dr. Thin's paper on the 'Structure of Hyaline Cartilage'* stimulated the conviction which I have long held and taught as to the uniformity of structure; and I have endeavoured to convince myself of the existence of *normal* fibrillation in human cartilage, if it were possible. Some weeks ago I placed the fresh articular elbow-ends of the humerus, ulna, and radius of a woman aged 65, whose arm had been amputated for the results of senile gangrene, in a 0·5 per cent. silver solution for ten minutes. They were then removed and exposed to the light in the dry state (i. e. without being placed in any liquid) for nearly three days. I had intended to examine them at once, but other work prevented it. On making horizontal thin sections, and examining them first as they were and without a cover-glass, and subsequently other similar sections in glycerine, I was struck with the

* 'Quarterly Microscopical Journal,' January 1876.

appearance of straight bands running in various directions and planes, separated by bright but somewhat interrupted lines, which in some parts appeared to be made up of minute round elements, reminding one of the 'elastic grains' described and figured by Ranvier. I must mention that the cartilages were washed in ordinary water before immersion in the silver, and that the capitellum was rubbed with a clean towel, in order to get rid of adhering synovia. My object in doing this was to avoid any false appearances caused by the deposition of silver in the synovia and the subsequent shrinking of the latter. Thinking that this appearance might perhaps be due either to the age of the woman or to the fact of the limb having been so long inflamed, or to the change effected during the three days the cartilages were exposed, I examined the cartilages of younger people very shortly after removal, fresh and without any reagent, and also after staining in gold, silver, and aniline dyes; also in salt solution. I almost invariably recognized the same appearances; but they are not so distinct in fresh as in stained preparations. The fibres are perfectly straight, in this respect and in others differing from those figured by Dr. Thin of the kitten and sheep. In some of the sections, rounded, oval, and irregular figures—probably the transverse sections of similar fibres—were visible; but on this and other interesting appearances I intend to dilate more fully ere long. It is important to note that these appearances are not in any way artificial or due to the methods used, as perhaps may be said of the methods Dr. Thin employed, and of those of Tillmanns and Baber. The fibrillation is a continuous right-lined one, differing much from that figured by Tillmanns and Baber. Once recognized on stained sections they are readily made out in fresh ones. The gold method I employed was the following. Fresh articular ends of bones were placed for twenty minutes in a 0·5 per cent. auric chloride solution. They were then allowed to remain all night in a 0·02 per cent. solution, and in the morning were removed and exposed to the light in the dry way all day. In the evening, horizontal sections were made and examined. I may add that, after taking every possible precaution to avoid fallacy in silver preparations, I observed figures very similar to those represented by Tillmanns, which he deems artificial, of which more anon."

The Sporules of Seaweeds the cause of Colour in Oysters.—Mr. F. Buckland states, in a late number of 'Land and Water,' that the green-bearded oysters which are found not far from Southend, Essex, owe their green colour not to any mineral pigment. This peculiar green is imparted to them by the sporules of the seaweed called "crow-silk," which grows abundantly in the Roach River. Dr. Letheby's analysis has pronounced this pigment to be purely vegetable, without the slightest trace of copper or other mineral. Mr. Buckland considers that this vegetable pigment imparts a peculiar taste and agreeable flavour to the meat of these plump little oysters.

The Anatomy of Moths.—In a work which is entitled 'A Monograph of the Phalænidæ or Geometrid Moths of the United States,'

by A. S. Packard, jun., and which forms vol. x. of the final reports of the United States Geological Survey of the Territories, F. V. Hayden in charge, the author has gone very minutely into the subject of the structure of this Lepidoptera. The chapters to which the attention of microscopists is especially directed are entitled Comparative Anatomy of the Head, Comparative Anatomy of the Thorax, Development of the Thorax of the Imago, Secondary Sexual Characters of the Imago, and to the essay on Geographical Distribution. The imagines of about four hundred species and the early stages of some are described and figured.

The giving of New Specific Names.—We have some faint hope that the statement which has been published in the December number of 'Grevillea' may have the effect of somewhat abating the nuisance which exists of multiplying specific names. A misconception seems to be current amongst some botanists that a MS. name in a private herbarium, or the description of a new species printed in a report which is circulated privately, or printed only for the use of a public department, is sufficient to establish priority for that species. In order to establish any claim for priority, the gentlemen whose names are subjoined hold that the species must be *published*, either by the circulation of specimens in published fasciculi, or by description in some work accessible to the public. A privately, or exclusively, printed report which is not sold or published, is no security for priority of name. They say: "We hold that unless a name or description is so published that it is accessible to botanists, its author cannot claim for it any other right than that of a manuscript name. It is presumed that if a description is *published* it is known, or might be known, to all botanists, but such presumption cannot be extended to names or descriptions *privately* printed; for acquaintance with which no facilities are offered either by purchase or otherwise. We are assured that we are only expressing the general view of this subject which is recognized by all European naturalists. It would be manifest injustice to expect naturalists to respect names with which they cannot possibly become acquainted through the ordinary channels of scientific literature. The first *published* name, when accompanied by a sufficient diagnosis for the identification of a species, has recognized priority. Had not this plain doctrine been ignored or controverted, we should not have considered such an explanation necessary.

"M. J. Berkeley, J. M. Crombie,
"R. Braithwaite, F. Kitton."
"M. C. Cooke,

Cell-division studied Microscopically.—This important subject has had a valuable paper devoted to it in a late number of the 'Comptes Rendus,'* by M. H. Fol, which is well abstracted, although the language of the original is technical in style, in a late number of the 'Academy.' He has not studied the subject in the case of the Vertebrata, but he has examined the nature of the process of cell-division

* No. 13, vol. lxxxiii.

as it occurs among sea-urchins, and he states that "centres of attraction appear, before each division, at two opposite poles of the yet absolutely intact nucleus, and seem to consist in a local fusion of the substance of the nucleus with the vitelline protoplasm, or perhaps an irruption of the protoplasm in the more fluid interior of the nucleus. At these two little masses of sarcode soon appear rays of sarcode, some of which extend into the interior of the nucleus from one centre of attraction to the other, while others diverge in the vitellus." The author then remarks on certain points on which he differs from M. Bütschli, and states that the medium best adapted to bring out the true aspect is picric acid followed by glycerine. Osmic acid, he says, usually causes the disappearance of the extra-nuclear filaments.

Researches on the Echini.—'Etudes sur les Echinoïdées,' par S. Loven, from Kongl. Svenska, Vetenskaps-Akad. Handligar. Vol. ii. No. 7. 4to, with 53 plates. 1875.—The writer of the short notices in 'Silliman's Journal' states that this very important work, although published some time ago, has only just reached him. It is mainly devoted to a very thorough and complete study of the skeleton and external organs of the entire group of Echini. A few new forms are also described and figured.

Structure and Movements of Dionæa muscipula.—An important paper was published on this subject in the beginning of the year by M. C. De Candolle, of Geneva; and in the September number of 'Silliman's Journal' Dr. A. Gray, who may be considered one of the first authorities on the subject, makes the following remarks:—"One noteworthy suggestion—which has already been made here—is that the sudden change of electrical current at the closing of the trap, ascertained by Burdon Sanderson (and much insisted on, on account of its accordance with what takes place in muscular motion), may have had its importance much overrated. The electro-capillary currents, which Becquerel long ago demonstrated in vegetable tissues generally, would almost necessarily be influenced in some such way by the displacements of liquid which would accompany any such abrupt change in the turgescence of the parenchyma. In some experiments made three years ago by Professor Trowbridge, of Harvard University (which, unfortunately, were not followed up), it was found that the strong bending of an internode of stem, without lesion, produced a similar electrical effect. M. Casimir De Candolle fairly deduces from his experiments the conclusion that animal matter is not necessary to the development and vigour of *Dionæa.* He goes on to the conclusion that the animal matter of the insects caught is not directly utilized by the leaves. This does not follow. Very much evidence would be required to rebut the presumption that the organic matters absorbed are somehow (and even directly) utilized by the plant. The independent movement of the border of the trap with its fringe of bristles is explained by the anatomical structure, which is, as it were, distinct from that of the main body. The glands are stated to belong to the epidermis only; but the excitable bristles are connected by the cellular bulb with the sub-

jacent parenchyma, so that impressions upon the former may readily be transmitted to the latter. The closing of the trap results from the comparatively permanent elastic tension of the largely fibrous external part of the leaf. It opens by counter-action of the parenchyma of the upper or inner side, through turgescence; the closing results from the sudden diminution of the turgescence, in some unexplained way. In other words, the trap is held open, and at the proper moment is let go."

Fungi on the Bones of a Whale.—Mr. C. B. Plowright states that about a year ago a young whale was stranded near Lynn, and in due course the bones passed into the possession of a manure company. They have been exposed all the time to the weather, and during the spring and summer were covered abundantly by an orange Fusarium, as well as by certain moulds. The skull has been sawn in two, and from a crack in it sprang, during the autumn, a cluster of Agarics, very near, if not identical with, *A. bullaceus*, Fr., the main points of difference being the cæspitose habit, and the margin of the pilei becoming striate or even corrugated as the plants dried. A few days ago, in the very centre of the cranium a cluster of *Agaricus ostreatus*, Jacq., made its appearance, apparently luxuriantly, upon a thin stratum of dry cerebral matter that lined the interior of the cavity.*

Specks in the Cape Diamonds.—It seems that Dr. Cohen, of Heidelberg, has examined the "specks" which are to be found in many of the crystals of diamonds from the Cape. He thought at first that they were particles of another modification of carbon. In a large diamond, weighing eighty carats, however, he discovered a crystal of specular iron, the larger faces of which lie parallel to the octahedral face of the diamond. Lustre, colour, and form (rhombohedral) all combine to identify it with specular iron, and the crystal in its habit closely resembles those occurring at St. Gothard. His paper, which was communicated to the Versammlung des Oberrheinschen geologischen Vereins, 1876, and is printed in the 'Jahrbuch für Mineralogie,' 1876, contains some interesting observations on the connection existing between the flawed character and the colour of Cape diamonds.

The Microscopic Zoology of the Arctic Expedition.—We of course cannot tell when the report will be published, but we are glad to learn from a paper by Mr. E. A. Alston in the 'Academy,' November 11, that "every opportunity was embraced for dredging and trawling, and a fine collection of marine invertebrates is the result. Many of the minute pelagic forms which it is so difficult to preserve are the subjects of beautiful drawings by Dr. Moss, and a complete series of soundings illustrates the character of the sea-bottom from Baffin's Bay up to 83° 19′ N. lat. Insect life was more abundant than could have been expected, and a good number of species were obtained. Botany has received full attention. Our explorers were rewarded by the discovery of between twenty and thirty species of phanerogamic plants between the parallels of 82° and 83°—a much

* 'Grevillea,' Dec. 1876.

greater number than was anticipated—and Mr. Hart's collections at lower latitudes are both rich and interesting. The cryptogamic flora was of course much more varied and abundant.

The Relation between Activity of Nerves and the Size of their Sheath.—Dr. R. Saundly ('Medical Record') reports that Herr Dr. R. Arnt states that a comparison of the facts derived from anatomical observations, human and comparative, and the results of clinical and pathological investigations, shows that the development of the medullary sheaths stands in direct proportion to the activity of the nerve-fibre. In the lower animals and in the embryo, many nerve-fibres are naked, and the development of the medullary sheath takes place by the formation of small round cells (Kugelchen), which arrange themselves around the nerve-fibre, and finally melt together to form a homogeneous sheath, which thickens by additional concentrically formed layers. He considers its formation to be due to functional irritation.

Fungi parasitic on Corals.—Dr. Duncan, F.R.S., has given an interesting paper on this subject to the Royal Society,* and we should have endeavoured to obtain it for publication but for the great expense of reproducing the plates. The following is a summary of the facts elicited by the author's researches: Quekett, Rose, Wedl. Kölliker, and Moseley have noticed and described the borings of vegetable parasites in molluscan shells, fish-scales, and corals; but no special attention has been paid to the filaments penetrating the last-mentioned organisms. Corals from the littoral zone down to 1095 fathoms are frequently the seat of the parasitic growth of two kinds of *Achlyæ*, whose horizontal range is from Davis Straits to the tropics and 15° S. lat. Fossil corals of Silurian age were also affected by closely allied, if not specifically identical, growths. The method of investigation is by making thin sections of the sclerenchyma, and also by dissolving out the carbonate of lime. The parasites are filamentous, and fill up the canals which they form; they resemble a mycelium, and penetrate the coral, living upon the organic basis, and having their length, breadth, and straightness, or branchings, dependent on the peculiar nature of the arrangement of the spicula in the different species of the Madreporaria. The entry is made from oospores, zoospores, and by the accidental contact of the parasites whilst perforating algæ situated on the wall of the coral; and the penetration and growth appear to be the combined results of the formation of a soluble bicarbonate of lime by the action of carbonic-acid gas evolved from the growing end of the tubular filament, of the pressure incident to growth, and of the movements of the cytioplasm and the cell-wall. The vegetative life of the parasites is accompanied by reproductive efforts within the corallite; for the aggregation of granules within the viscid transparent cytioplasm can be detected, and their formation into large conidia and into small unciliated zoospores also. Following the peculiar physiological habit of the Saprolegnian group of *Achlyæ*, the reproductive elements germinate and produce either large or very small tubes which, after penetrating the parent cell-wall, get through the solid investment,

* 'Proc. Roy. Soc.' No. 174.

and become indistinguishable from the filaments derived from spores attached to the outside. The diameter of the largest canals containing filaments in which there is occasionally a doubtful dissepiment, and which flourish in the organic matter between the laminæ of a septum, is $\frac{1}{300}$ inch; that of the typical and ordinary tubes is from $\frac{1}{1500}$ to $\frac{1}{8000}$ inch; and the finest tubes are as small as $\frac{1}{20000}$ inch in diameter. The canals and included filaments in some instances increase in calibre at certain spots, and even form globular expansions, but usually the same diameter is retained; the enlarged portions relate to the reproductive process. The cell-wall of the filament is in close contact with the sclerenchyma of its canal. In a littoral species (*Caryophyllia Smithi*) the parasite is identical with *Saprolegnia ferax*, Ktz.; but there is a manifest distinction between it and those of the other forms. The parasite of the littoral coral greatly resembles those of the shells of Mollusca and of the scales of fish. Although it is quite possible that all the parasites of the corals described may be referred to one species, their type being altered by the peculiar conditions surrounding them, still it is thought advisable to regard them as members of two species. The classificatory position of the parasites is in the midst of a group of forms which have complicated life-cycles, such as the Achlyans (proper), the *Saprolegniæ* and *Empusinæ* and *Botritidæ*, and the filamentous false-root bearing genera *Codium* and *Bryopsis*—forms which are more or less the expressions of one organism under different conditions and age.

Phallus fœtidus. — Mr. Meehan exhibited to the Phil. Acad. of Science, at its meeting in October last, specimens of what he supposed to be a variety of this fungus. It was very rare with him, the last time it had appeared on his grounds was seven years ago. Its brilliant scarlet colour and strong fetid odour would have attracted attention had it been in existence during that time. It was doubtful if any existed in the vicinity, and it was an interesting question whether the spores or mycelium had been in the ground all that while, or whether it had been recently brought as a spore in the atmosphere. But the main point he wished to draw attention to was the attraction the fetid plant had for meat flies. They abounded on the plants. The common toad plant of greenhouses (*Stapelia variegata*) attracted these in the same way, and it was said to be a scheme to aid the plant in cross fertilization, the stench attracting the flies, and inducing them to deposit eggs, under the impression that it was rotten meat; though what benefit it was to the fly to be thus fooled had never been made clear to him. In the case of this fungus, however, it would hardly be contended that the flies had been deceived for the purposes of fertilization, nor could he understand why "in-and-in breeding," if bad for phænogams, should not be injurious to a fungus as well.

The Structure of Precious Opal.—At a recent meeting of the Academy of Science of Philadelphia, Professor Leidy stated that Signor A. G. Arevalo, proprietor of one of the opal mines in Queretaro, Mexico, had recently called upon him, and exhibited a large collection of cut opals of various kinds, comprising the milk-white opal with a rich harlequin display of colours, the less valued transparent glassy variety with rich hues, and the red fire opal of different shades,

also displaying the play of colours of the spectrum. From among them he had selected several which he exhibited to the Academy as illustrating in an unusually distinct manner the structure of the precious opal. One of the specimens is white opal, emitting on one side from the free surface a brilliant display of colours. These are reflected from facets ranging from $\frac{1}{4}$ to 1 mm. in breadth, and of irregular polyhedral form. The facets are distinctly separated by fissures, which, in the polishing of the stone, have become more or less filled with dirt, and they appear to form the surface of a mosaic pavement laid on a basis of amorphous opal, of which the other side of the specimen consists. The facets are distinctly striate; the striæ being parallel on the same facet, but changing in direction on the different ones, though pursuing the same general course over comparatively large areas, as represented in the same figure. The striæ, or tubes as Sir David Brewster considered them to be, vary in degree of fineness; some apparently being double or more the thickness of others. He had not attempted to measure them accurately, but they appear to be about the size of the lines in the ordinary micrometer eye-piece of the microscope. There appeared usually to be about four or five striæ in the space of $\frac{1}{40}$ of a mm. Another specimen is a dark carnelian-hued fire-opal, which exhibits in directly looking upon it, just beneath the surface, a patch of round or oval spots of a deeper hue. The spots range from $\frac{1}{4}$ to 1 mm. in breadth, and are separated by interspaces from $\frac{1}{8}$ to $\frac{3}{8}$ of a mm. The spots appear as lenticular disks with finely striated surfaces; the striæ being parallel, and on the different spots pursuing nearly the same course. Viewed at a certain angle, they mainly emit a rich golden-green hue. In another opaque white specimen, emitting rich hues, the striated facets are more or less isolated by amorphous opal, and vary much in size. The smaller facets are generally irregularly oval; the larger ones appear to be made up of an aggregate of the smaller kind. Over comparatively large areas, the striæ of the different facets pursue nearly the same direction, but in contiguous areas they even pursue quite opposite directions. On the larger patches, also, as I have attempted to represent them, the striæ are not perfectly continuous, but appear to be rather interrupted in bands. On another part of the same opal the brilliant patches would appear to pertain to cylindroid or fusiform rods of the striated opal imbedded in amorphous opal. The striæ in these rods appear to be arranged in regular parallel layers, so that either longitudinal or transverse sections give rise to the appearance of parallel striæ. From these specimens precious opals would appear to be constituted of an aggregation of particles of a striated or finely tubular structure which may be imbedded in a basis of more amorphous opal. When isolated by the latter, the particles may appear as lenticular disks, round or oval balls, or cylindrical rods with rounded ends and of variable length. When closely aggregated these particles become more or less polyhedral. The particles in section in any direction present a striated appearance, and, according to the varying fineness of the striæ, and their inclination, emit the varied hues for which the precious opal is so much admired.

Microscopical Contents of Foreign Journals.

Archives de Physiologie, No. 1, 1876.—Histological Researches on the Tracheæ of *Hydrophilus piceus*, by M. C. S. Minot, with two plates. In this paper the author goes into the whole subject of the tracheæ and their relations to adjoining tissues. The author, by adopting the picro-carminate mode of staining, has been able to make out the distinction between the small cells and large ones of the external epithelium. He describes the structure of the tracheæ minutely.—Note on the Structure of certain Tubercular Granulations of the Testicle, by M. L. Malassez. This has two good plates.—Note on a case of Myelitis, by M. Pierret. A plate.

Archiv für die gesammte Physiologie, &c., Band 14, Heft 4 and 5.—The only paper of microscopical interest, and that is only half so, is one on the Histological Structure of the Small Intestines, by A. Fortunatow, of the Physiological Institute of the University of St. Petersburg.

Journal de l'Anatomie, par Chas. Robin. No. 1, 1876.—On the Changes of Colour caused by the Influence of the Nerves, by G. Pouchet. This paper is said to be illustrated by four plates, but unfortunately they have not been placed in the present number. This is a most important memoir, being the one selected by the Academy of Sciences of Paris for the prize in experimental physiology. It relates many experiments conducted over the whole range of vertebrated animals, which prove that the changes of colour are produced by the influence of the nerves on the so-called chromoblasts. This paper extends to 90 pages.—The second paper is a short one, but it is of especial interest to the microscopist. It is by M. M. Duval, and is upon the mode of colouring sections of the nervous system. The chief value of the method is that it gives a distinct sort of coloration to the nerve-cells and axis-cylinders on the one hand, to the vessels on the other, and, lastly, a distinct tint to the envelopes (the pia-mater) of the chord. The mode consists in adding to the red colour obtained from carmine the blue colour due to one of the aniline dyes. From this there results a violet tint which differs in accordance with the structure of the particular parts.

Zeitschrift für Anatomie und Entwickelungsgeschichte. Herausgegeben von W. His and W. Braune. 2nd Band, 1st and 2nd Heft. Leipsic, 1876.—The more important microscopical papers are:—On the Lymphatics of Bone, by Professor G. Schwalbe. This paper has not any illustrations, and we do not see that it adds much to what has been done already by Langer and Budge.—A more valuable communication is that of one of the editors, Professor W. His. It is on the Structure of the Embryo of the Dog-fish. The author follows the development of this creature from the time when the ovum has begun to undergo its first changes after impregnation, until its development is completed. The important point in the paper is its bearing on the researches of Mr. Balfour on the development of the dogfish.

That is to say, the point in this paper, as in Balfour's, is that relating to the caudal lobes, which are caused by a thickening of mesoblast on each side of the hind end of the embryo at the edge of the embryonic rim.—A paper which is partly microscopical is on "the Anastomoses of the Hypoglossus Nerve," by Herr M. Holl. —The Lymphatics of the Testicle, by Dr. K. Gerster, of the Pathological Institute of Bern. This is a good paper. It is illustrated by two plates, one plain, and the other coloured. The plain plate strikes us as a little too perfect. The staining material used was carmine and a combination of carmine and aniline blue, which certainly, to judge from the drawing, has acted very well.

NOTES AND MEMORANDA.

Death of David Forbes, F.R.S.— One of our great naturalists has been taken away from us. David Forbes has died within the past month, at the early age of forty-eight years. Most of the labour of his life had been spent on his favourite topics, those of mineralogy and physical geology. And on these two subjects he has left probably far more material behind him than has been already published. But in the branch of microscopic geology he has done much good work, and of this not the least was the set of papers, splendidly illustrated, which he published in the 'Popular Science Review,' on the subject, then a new one, of the "Microscope in Geology." These papers were subsequently reprinted in two German periodicals, so highly were they thought of at the time; and they may be said to have led English geologists to the pursuit of micro-geology. Of his labours in geological science this, of course, is not the place to speak. But in conclusion a word may be offered on his personal characteristics. David Forbes was, like his famous brother Edward, a man who loved truth above all things. He was a keen critic of the scientific doings of his fellows, but withal a generous one, and his onslaughts when made were usually on his elder and rarely on his younger brethren. He was invariably kind and genial in manner; one who thoroughly detested hypocrisy, and admired the blunt and honest outspoken man, who freely expressed his opinion regardless of the consequences. As a host, those who have had the good fortune to possess his friendship knew him best; and of them it is not too much to say, that they have indeed lost a friend whom it will be difficult to replace, and who will most assuredly be lovingly remembered by them all the days they live.

Death of Von Baër.—We have much regret in announcing the death of this veteran embryologist, the father, we may say, of the

study of development. He had reached the advanced age of eighty-four (84) years. Karl Ernst Von Baër was, though of German descent, yet a Russian by birth, having been born toward the close of the last century in Esthonia. However, he studied medicine in Germany, and in 1817 he received the appointment of Professor of Zoology in the University of Königsberg, which he held till his return to St. Petersburg in 1837. His greatest work, which will make him famous for many centuries, is his history of the development of the human ovum, and it, which was published at Leipzig in 1827, was of course the result of labour executed in the celebrated German University. This book is in Latin (4to), and bears the title 'De Ovi Mammalium et Hominis.' His later essays on development were published in the German tongue, and among the more important may be mentioned his 'Ueber Entwickelungs-geschichte der Fische (4to), and his 'Ueber die Gefaessverbindung zwischen Mutter und Frucht in den Säuge-thieren' (folio).

Van der Weyde's Oblique Illuminator.—Dr. R. H. Ward has sent us the following note, contributed by him to the December number of the 'American Naturalist,' and as it bears upon a question as to priority of invention, it will doubtless interest our readers:—"At the Indianapolis meeting of the American Association for the Advancement of Science, in August, 1871, P. H. Van der Weyde, of New York, described a contrivance, believed to be new, for oblique illumination of transparent objects. It was designed chiefly to facilitate the resolution of lined or dotted objects, and consisted of a plane mirror lying beneath the object-slide and parallel to it, from which mirror light, condensed upon it from above by means of a bull's-eye condenser, would be reflected back at the same angle through the object and into the objective. These illuminators were shown in successful operation at the meeting, working best with moderately high powers, and were freely distributed among the members present. They were briefly described in the 'American Naturalist' for September, 1871, being there estimated as 'a little expedient of great practical convenience.' Ever since that time the present writer, among others, has used them habitually, shown them freely, and not unfrequently given them away. The mirror may be either of silvered glass or of polished metal. In some cases the object-slide may lie directly upon it while it rests upon the stage; but frequently the object-slide is best elevated slightly above it. The mirror is most conveniently made of the size of a slide (3×1), and furnished with glass strips at the ends to support the slide at any required height; but it may be made smaller, say one inch square or round, and sunken in a brass or wooden stage-plate, or for stands having a sub-stage of any kind it may be made of suitable size and supported from the sub-stage and adjusted for height in the same manner as the achromatic condenser. It has the advantage of great ease of manipulation and applicability to any stand, and the drawback of being liable to be interfered with by the presence on the slide of such obstructions as paper covers or opaque cells or rings

of varnish. Within a few months past it has been brought forward by Rev. John Bramhall, of Lynn, England; its previous use and publication having either escaped the notice or slipped from the memory of himself as well as of the distinguished microscopist who has indorsed it and proposed to name it after him."

CORRESPONDENCE.

Mr. Ingpen's Standard of Measurement of Magnifying Power.

To the Editor of the 'Monthly Microscopical Journal.'

Sir,—I did not think that the description of my exhibit at the last Scientific Meeting of the Royal Microscopical Society would be printed, or I would have stated the *general principle* of my proposed standard for measuring the magnifying power of microscopes. My note referred only to the instrument exhibited. The principle is as follows:—A diaphragm of any convenient size is placed at a distance of ten times its diameter below the surface of a slip of glass in the position of the object on the stage. The diameter of the diminished image of this diaphragm, as seen above the eye-piece, is measured. Then $\frac{1}{\text{diam. of image}}$ = the magnifying power employed, referred to a distance, or length of body equal to ten times the unit of measurement. Thus, if the unit be an inch, the power is referred to a standard of 10 inches; a larger or smaller unit increases or diminishes the standard of power rateably, but is easily converted into a 10-inch standard. The size of the diaphragm is immaterial, provided that it is placed at ten times its diameter below the focus of the objective, and a slit or scale can also be used. The measurement of the diminished image is easily effected by means of a second microscope, having an eye-piece micrometer of known value, placed in a line with, and looking into the eye-piece of the first microscope, both being horizontal.

I remain, Sir, yours obediently,

John E. Ingpen.

PROCEEDINGS OF SOCIETIES.

Royal Microscopical Society.

King's College, *December* 6, 1876.

H. C. Sorby, Esq., F.R.S., President, in the chair.

The minutes of the preceding meeting were read and confirmed.

A list of donations to the Society was read by the Secretary, and the thanks of the meeting were voted to the donors.

The President exhibited a facsimile of the first compound microscope ever constructed, made in 1590 by Zacharias Janssen, which he had been allowed to copy from the original in the possession of the Scientific Society of Zeeland, at Middleburgh, in Holland.

A paper by the Rev. W. H. Dallinger, "On *Navicula crassinervis*, *Frustulia Saxonica*, and *Navicula rhomboides*," was read by the Secretary, and a series of very beautifully executed drawings in illustration was exhibited. The paper appears at p. 1.

The President, in proposing a vote of thanks to Mr. Dallinger for his communication, considered it very interesting in more ways than one, and that the manner in which the investigations had been carried out was most excellent. The remark made towards the end of the paper was worth remembering—that to say a lens would resolve a certain kind of diatom was a statement of little value, seeing that the varieties of the same kind were so very different in size and resolvability. He judged, however, from the paper that there was no difference between the fineness of the markings of frustules of the same species, provided that they were of the same size; so that if the size of the specimen resolved by any lens were stated, a much more definite opinion could be formed of its quality. With regard to some of the statements made by Dr. Woodward, he would mention that he wrote to him some time ago, and suggested whether there might not be some difference observed in the number of the markings when light of different kinds was used. Dr. Woodward had told him he had tried some experiments in the matter, and believed there were some such differences, but it would take much time to follow the matter up thoroughly. He hoped that at some future time they should hear further upon the subject. He thought, if they might judge from the tone of what had taken place lately, there seemed to be just now a great tendency to reverse the process adopted by naturalists some time ago, of adding as much as possible to the number of species into which a genus could be divided, by now uniting all the extreme varieties.

A vote of thanks to the Rev. W. H. Dallinger was unanimously carried.

Mr. H. J. Slack thought these drawings of Dr. Dallinger's were very interesting in an optical point of view. Microscopists were often told by others that they spent their time in counting dots and scratches; but unless, as in this case, they did give some careful attention to these dots, they would be likely to miss facts of the greatest

use. He knew there were some, and amongst them was Professor Abbe, who went so far as to say that the results obtained by the use of high powers on diatoms were entirely fallacious, and he had prepared a number of diffraction slides to prove it. He had himself seen these experiments at his own house, and he hoped that there would be an opportunity for them to be shown to the Fellows of the Society. But although it might be possible to produce very remarkable appearances by means of a number of gratings ruled in particular ways, this would not prove that they could not also get effects of similar aspect due to real structure. Whether these appearances could be relied on or not, was a question which a series of diatoms such as those before them gave very great help in solving, for they saw there a large number of specimens of the same species differing only in what might previously have been expected from their difference in size, and when they got this effect they might be tolerably sure that there was some sort of reality about it. He received some time ago a slide from Mr. Baker on which he could show in the same field of view a valve of Rhomboides with the rows of beads running as Mr. Dallinger showed them, and another which showed them running in a serpentine form. It was quite certain in this case the latter were spurious, but there was no reasonable doubt that the others were real. He did not know whether a drawing of Dr. Pigott's had been shown there which had some bearing on the subject. Dr. Pigott was making some observations upon these spurious images by directing his telescope upon the bulb of a small mercurial thermometer, and he found that when the sun shone upon it he could see nothing but diffraction rings, but when a cloud came over the sun he could see a perfect reflexion of his own house. He had himself noticed a similar effect when trying to see with his telescope the two little companions of the Pole star; when diffraction rings were seen plainly, these small stars were invisible; but on a fortunate evening, when there was much light in the sky, they were seen quite distinctly.

Dr. G. C. Wallich said he had observed that the size of the diatoms depended upon the size of the first frustule which grew from the sporangium in any given pool. He had repeatedly found this to be the case in India, where they grow very rapidly; the result being that all which came from the same pool were the same size. They would find in the collection in the Society's cabinet * some gigantic specimens of *N. crassinervis* in which the markings were very coarse. He was excessively glad to hear what Professor Abbe has said on the subject, because it was exactly his own opinion, for the expression of which he had got rather severely handled some years ago.

Mr. Ingpen suggested that, after all, the question of genus and species depended upon difference in shape, and not upon the absolute number or fineness of the lines. He had not paid much attention to the subject, and therefore did not speak with authority; but in the specimen of *N. crassinervis* there were decided nodules at the end of the median line which the other closely allied forms did not possess. He could hardly say that the specimens drawn by Dr. Dallinger were

* Presented to the Society by Dr. Wallich.

all alike in these particulars; the larger specimen had not got the rhomboidal curve at all, and the drawings showed a distinct difference in this respect. One had a larger nodule at one end than at the other; another had a nodule at each end; the small ones had no nodules, but were of angular form; whilst another differed altogether in having a beautifully curved outline. He mentioned these differences as bearing upon the question whether the species should not be determined by the shape and nodules rather than by the number of the striæ.

Dr. Wallich, in reply to a question from Mr. Slack, said he quite agreed with Mr. Ingpen that the larger specimen was distinctly different from the others, and that it had not the rhomboidal outline. He might also mention that in preparing these diatoms, if they were boiled too long in acid, all the material would be boiled away except the median column, and with a less degree of boiling they would constantly find the lateral parts would break away in the acid.

The President said it appeared to him that it was a point well worthy of investigation whether or not there was a series of connecting links between the specimens.

Mr. Slack asked if Mr. Ingpen would examine the specimens from Cherryfield in his own collection, and see if they differed in these respects.

Mr. Ingpen said he would do so; the point of importance was whether the small specimens and the large ones were the same species. If he should be called upon to name the large one, he should hardly call it a Rhomboides at all.

Mr. Slack suggested that if diatomists would allow Triceratium to go up to seven angles, they need not take much notice of such slight variations.

The President said that the question before them was not the mere determination of species, but very important physical facts were connected with and lay at the bottom of it; which had a most important bearing on a very great number of investigations in many different branches of science.

Donations to the Library since November 1, 1876:

	From
Nature. Weekly	*The Editor.*
Athenæum. Weekly	*Ditto.*
Society of Arts Journal	*Society.*
Verhandlungen.	
Proceedings of the Literary and Philosophical Society of Liverpool. No. 30. 1876	*Ditto.*
Bulletin de la Société Royale de Botanique de Belgique. No. 2. 1876	*Ditto.*
American Journal of Microscopy. No. 11	*Editor.*
Transactions of the Royal Irish Academy (Science). Five parts ..	*Academy.*
Proceedings of ditto. Three parts	*Ditto.*
Six sets of Photographs, with Pamphlets, &c. By Dr. J. J. Woodward	*Author.*

William Garrow Lettsom, Esq., was elected a Fellow.

Walter W. Reeves,
Assist.-Secretary.

Liverpool Microscopical Society.

The eighth ordinary meeting of this Society was held on Friday evening, November 3, at the Royal Institution, the President, Rev. H. H. Higgins, in the chair.

Mr. Edward Davies, F.C.S., made a communication on the *Didymohelix ferruginea*, formerly called the Gallionella, a genus of Oscillatoriaceæ (confervoid algæ) which is by no means common. Through the aid of an old pupil he had found it in remarkable quantity in drains and ditches in the neighbourhood of the Lochar Moss, Dumfriesshire, where it accumulates ten or twelve inches in depth. This deposit is locally called iron ore, and the careful analysis he had made showed that it contained 33·10 per cent. of iron. The Didymohelix is a test-object, for the general excellence of a high-power object-glass, also of the observer's management of the microscope.

Mr. G. F. Chantrell, Honorary Secretary, read a paper, "Recent Observations on the Development of Animal Life in Vegetable Protoplasm." He stated, after referring to a recent paper in 'Popular Science Review,' that he had devoted some time to the careful study of the *Volvox globator*, and had examined a large number during the recent summer; that there were two kinds,—the *early* stage, when they are vigorous and produce young volvoces, and a later one, in which remarkable changes of the contained spheres are seen, a gradual development into eggs, and finally the Rotifer; specimens of these he had shown to members of the Society, and said that there was no resisting the conviction that the Rotifers (animal) are developed in the Volvox (vegetable ?), or, in other words, that animal germs are taken up in vegetable protoplasm, just, as has been said, that Diatomaceæ are absorbed into the roots of plants, and are built up unaltered into their stem substance. These germs develop in the Volvox into eggs, and then hatch there. Mr. Chantrell said that there was no more remarkable instance of the power of vegetable protoplasm than is shown in the Oscillatoria which he had recently under observation. The name is derived from their singular oscillating movements. He had placed some in a live-box and kept them under observation two or three days; at first they were extremely active and life-like, reminding him much of the Spirilla. After two days these broke up into cells; after a time these loose cells began to form in small clusters, which still retained a slight restless movement; numbers clustered in a circular form, and these after a while were invested with a nimbus or ring forming a complete cell. On further investigation these cells showed movement of the contents, and contained many nuclei. These facts have been frequently verified. Mr. Chantrell then referred to the flow of protoplasm in the hairs or rootlets of the Hydrocharis, or frogbit, a well-known and common pond plant; and described three conditions of the circulation, showing, when it became languid and almost ceased, that living organisms are soon to be seen sporting about in the internode; that in the hairs of the Nitella he had seen, a few nights

ago, the same thing; that he had in one live-box the Nitella in vigorous circulation, an internode in which the circulation had ceased, and that this was crowded with living organisms, the majority of which were germs, eggs of animals, and animals themselves.

In another internode he saw an egg enclosed in a large hyaline cell, showing muscular contraction and the play of cilia, and which subsequently proved to be a Rotifer. The dead internodes of the Nitella vary in their contents, as shown in the accompanying illustrations of the typical varieties, many of which are to be found in Dr. Bastian's 'Beginnings of Life,' in his remarks on the Nitella; it will, however, take an immense amount of time and trouble to collate all the living forms that are to be found therein. In the experiment of treating wheat rootlets with carmine, to show the protoplasm, the plant has no difficulty in drawing up the minute fragments of colouring matter, by which the protoplasm is made evident. The spores or germs of animals are taken up in a similar manner, and are nourished and develop into life in the flowing protoplasm of the plant; and after circulation ceases, a gradual change goes on, until you have at last a whole menagerie of animal life, from the Rotifer downwards.

Mr. Chantrell said, in the light of his long familiarity with these low forms of life, that for years he had abandoned his belief in the line of demarcation between the animal and vegetable kingdoms, the relations are so intimate; and that many of our leading scientists are now coming to the same conclusion. The paper was illustrated by a number of drawings from life; and at the conversazione that followed Mr. Chantrell exhibited a Rotifer alive in an internode of the Nitella which was hatched there, and which was making frantic efforts to escape. It had been found the night before. An interesting discussion followed, in which the President (Rev. H. H. Higgins), Dr. Drysdale, Dr. Symes, and others took part.

Dunkirk (N.Y.) Microscopical Society.

Special Meeting, October 31, 1876.—George E. Blackham, M.D., President, in the chair.

Circumstances having rendered it inconvenient for the Society to meet in their rooms at the City Hall, Geo. P. Isham, Esq., invited the Society to meet at his residence. The invitation was accepted, with thanks.

The attendance of members and visitors was unusually large, and there were present by special invitation the following gentlemen, members of the Buffalo Microscopical Club, viz.: L. M. Kenyon, M.D.; Henry Baethig, M.D.; Henry Mills, Esq.; Geo. E. Fell, Esq.

The President, after a few words of welcome to those present, introduced Professor J. Edwards Smith, of Ashtabula, Ohio, who proceeded to read a long and highly interesting paper on "The Use and Abuse of the Microscope as an Instrument of Precision."

The paper was too long and exhaustive for justice to be done it in a summary. It is sufficient to say that Professor Smith took a position

radically opposed to many of the received ideas, and in favour of lenses of the widest angle of aperture for all kinds of work; even going so far as to express his opinion that most of the work in histology and pathology done with the so-called "working lenses" of narrow angle, would require further attention, and with wide-angled objectives which recent advances of the optician have put at our command.

After the reading of the paper, the meeting was resolved into a conversazione for the examination of the various instruments, objectives, and specimens which had been brought by the members of the Society and their guests.

Mr. Mills, of Buffalo, exhibited a beautiful specimen of Crouch's large binocular stand, and various lenses, among them an immersion No. 10 ($\frac{1}{16}$th) by Hartnack. The exhibition of the circulation in Chara, by Mr. Mills, under the binocular with a power of 75 diameters, attracted much attention. Dr. Kenyon exhibited a Powell and Lealand $\frac{1}{16}$th of recent construction, with dry and immersion fronts. Mr. Fell exhibited a late immersion $\frac{1}{16}$th by Gundlach. Professor Smith exhibited a Zentmayer army hospital stand with extra thin stage of his own design, Tolles' $\frac{1}{10}$th and $\frac{1}{6}$th duplex objectives of 180° (+) air angle, Tolles' $\frac{1}{2}$ and $\frac{1}{4}$ inch solid eyepieces, amplifier, &c.; also a microscope lamp of new construction. The flame of this lamp is only about $2\frac{1}{2}$ inches above the table. Kerosene oil is burned: there is no chimney, the draught being supplied by a small fan driven by clockwork: the lamp burns with a perfectly steady flame of great intensity.

The President exhibited a Queen's student's stand with three eyepieces, Tolles' 1-inch objective of 30° aperture, and Tolles' $\frac{1}{6}$th duplex immersion objective of 95° balsam angle.

The following severe tests were exhibited by Professor Smith to convince the doubting ones (of whom several were present) of the correctness of the positions assumed in his paper.

1. *Navicula* (*Pleurosigma*) *angulatum*, resolved into hexagons, direct light, central illumination being secured by a diaphragm plate perforated with an aperture $\frac{1}{200}$ of an inch in diameter, and accurately centered.

2. The transverse striæ of *Amphipleura pellucida* (*Navicula acus*)—the No. 20 of Moller's *balsamed* plate, illuminated by Wenham's "reflex" (in this case *direct*) illuminator: amplification 2000 diameters.

3. Nos. 18 and 19 of same probe-plate, with same amplification and illumination.

4. Resolution of the 19th band of Nobert's 19 band test-plate (lines 112,600 to the English inch) with ordinary oblique illumination 75° from axis.

(All of the above with Tolles' duplex (four-system) wet $\frac{1}{10}$th of 1875.)

5. Resolution of the 19th band of Nobert's 19 band test-plate with Tolles' $\frac{1}{6}$th immersion (duplex) objective of 1876, B eyepiece: amplification 540 diameters, illumination as in No. 4.

6. Resolution of third band of the same Nobert plate, 22,500 lines to the inch, with Tolles' 1-inch objective of 30° aperture, $\frac{1}{4}$-inch solid eye-piece, amplifier and draw-tube: amplification 740 diameters.

In view of the unusual nature of some of these tests, and the acknowledged difficulty of showing them by lamplight and in a crowded room, a statement that each and all had been shown, and that the resolution in each case was palpably strong and decisive, was drawn up, and has been signed by all the members of the Society, and their guests who were present.

Mr. Mills presented the Society with a beautiful slide of *Stephanodiscus Niagara* and a quantity of living Chara.

After a vote of thanks to Professor Smith for his paper and demonstrations, and to Mr. Isham for his hospitality, the Society adjourned.

San Francisco Microscopical Society.

The regular meeting of the Microscopical Society was held on Thursday evening, October 5, Vice-President Hyde in the chair.

Mr. C. Mason Kinne donated a slide mounted by him with spicules of sponge *in situ*, which was found, on examination, to be well adapted to show the manner in which the acicular spicules were thrust through the leathery portion of the animal.

Dr. Harkness sent a slide and some leaves, as set forth in the following paper.

Dr. Harkness' Paper.

Dear Sir,—I send to-day to your address, for the Society's cabinet, a few leaves of the *Xanthium strumarium*, a plant well known to the stockmen under the name of "cockle burr."

You will observe upon the under surface of the leaves many dark-brown spots, in some instances no larger than a pin's head, in others exceeding in diameter one-fourth of an inch. They may be found at the present time in the greatest profusion throughout the valley of the Sacramento. In many localities scarcely a leaf may be gathered which is free from them. These spots are formed by the aggregated spores of *puccinia* (a coniomycetous fungus), growing parasitically upon the plant.

The accompanying mounted slide contains a section of leaf showing the brand spores, each septate, with a dark-brown investment, and attached by a short stalk. Mingled with these are a few sub-globose bodies with yellowish contents; these are uredo spores, indicative of one stage of development of the fungus.

C. Mason Kinne, Esq.,
Secretary San Francisco Microscopical Society.

The regular meeting of the San Francisco Microscopical Society was held on Thursday evening, October 19. President Ashburner was in the chair, having returned from quite an extended tour among the microscopists over the mountains, and during the evening gave an interesting and full report of what he had seen and learned.

Mr. J. P. Moore presented the Society with two volumes of 'Spencer's Biology,' and Professor Ashburner stated that he had purchased for the Society, while East, one of Tolles' $\frac{1}{6}$th immersion objectives, one each of Tolles' solid one-half and one-quarter inch eye-pieces and a Wenham reflex illuminator, the latter of which was tested during the evening for oblique illumination while resolving some test diatoms, and it was satisfactorily proven that one of the greatest advantages of the accessory was its use with the ordinary thick stages, which preclude the obliquity of light necessary for tests with high powers. While speaking of this, President Ashburner stated that in his interview with Professor J. Edwards Smith, of Ashtabula, Ohio, he noted the fact that his stage was of extraordinary thinness, and was one of the apparent essentials when nothing but illumination from the mirror was used. The Society's duplex $\frac{1}{10}$th of Tolles' was used, and the Society's balsam Möller proof-plate, and Professor Smith showed Nos. 18, 19, and 20, clear and distinct within fifteen minutes, although he admitted that the Society's glass was not equal to his.

President Ashburner has proved an apt scholar in the manipulation of the objective, and from a subsequent interview with Mr. Tolles, and with the tenth overhauled and refitted, he is equal to the emergency, being able to show members of the Society the lines on 18, 19, and 20, as plainly as the pickets on a fence. The new Tolles' sixth also resolves in his hands the same tests without difficulty, on a balsam plate which is just what it represents to be.

Mr. J. P. Moore made a further statement regarding the grapevine fungus which he had examined and reported on at a previous meeting, to the effect that the same Erysiphe he had found since on the native vines.

Mr. G. W. Barnes, of San Diego, sent a communication to the Society, accompanied with a bottle of sediment obtained from the water supplied to that city from the bed of the San Diego river, and desired a statement as to its characteristics microscopically. It was handed to Mr. Hanks, who promised a report at the next meeting.

Dr. Wythe exhibited a photograph of Zentmayer's new model, and during the evening Mr. Banks filled one of the revolving tables with instruments just from the Centennial Exposition. Among them was Crouch's standard microscope, with new centering arrangement, which was most perfect; one of Walmsley's binocular stands, and a Holmes' class stand.

The regular meeting was held on Thursday, November 2, with Vice-President H. C. Hyde in the chair.

Mr. H. G. Hanks donated a quantity of material for mounting in the way of Cinnabar crystals, showing double termination, from Sulphur Bank, Lake County, California. He also exhibited a specimen of beautifully crystallized Polybasite, from Austin, Nevada, which silver mineral is rarely found so interesting.

Referring to the sample of water handed to him at last meeting, Mr. Hanks presented a paper embodying the facts ascertained in his

examination, as follows [and as most of the remarks are on the subject of chemistry, these are omitted from the 'M. M. J.'—Ed.]:

A careful microscopic examination revealed only the lower animal forms usually present in fresh water.

There is an absence of diatoms and other vegetable forms, which is peculiar.

The water was filtered off and examined chemically. The only noticeable feature was the presence of an unusually large quantity of ammonia.

Mr. Attwood presented to the Society four slides, with the statement that the alluvial gold marked "No. 1," from Sea margin, Otago, New Zealand, very closely resembles that which he had examined from this coast, the gold presénting the same scaly and laminated character, with a beautiful, clean and bright surface, rendering it so easily acted upon by mercury, and apparently so well fitted for amalgamation. No. 2. Section of Smaragdite rock from Gilroy: an exceedingly beautiful section, the smaragdite forming a compact matrix, in which crystals of garnet are porphyritically enclosed. No. 3. Section of Smaragdite rock from Bavaria. No. 4. A section of trachytic greenstone from the C. & C. Shaft, Virginia City. It is the same character of rock as that met with in No. 4 Shaft, Sutro Tunnel, the smaragdite having small particles of magnetite imbedded in it.

Mr. Attwood also exhibited nineteen specimens of alluvial gold from New Zealand, which had been presented to him by Dr. Hector, Director of the Geological Survey of New Zealand. Small portions of each specimen were mounted on slides for microscopic examination, and were from the following localities:—No. 40. Torrent washed, Otago. No. 14. Lake margin, Otago. No. 16. Sea margin with iron sand, Otago. No. 3. Tertiary sea beach, Nelson. No. 39. Tertiary lake beaches, Otago. No. 17. Tertiary river terraces, Otago. No. 33. Re-wash of river terraces by sea, Otago. No. 29. Re-wash of lake beach by sea, Otago. No. 23. Re-wash of lake or stream gold, Otago. No. 34. Older gold drift of Otago: Eocene. No. 8. Older gold drift of Westland, Pliocene, 130 feet below the sea. No. 6. Ditto, 1700 feet above the sea. No. 15. Torrent-bed in mesozoic rocks. No. 2. From old conglomerate (cretaceous age) coal-measures, Westland. No. 21. Creek placers. No. 2. Silurian. No. 4. Devonian. No. 3. Hydraulic sluicing of gravels in base of mountains. A. Native crystals of gold alluvial from mica schist.

Dr. Harkness sent the Society some leaves with a fungus found on them, and also a slide, mounted by him, with spores of the same, which was accompanied by the following paper:

I have to-day sent you, for the Society's cabinet, a slide—No. 283—together with some willow leaves infested with a fungus. These diseased leaves are found at the present time in the greatest profusion upon the willows skirting the Sacramento River. You will observe that the fungus appears both upon the upper and under surfaces of the leaves, in bright yellow heaps (sori), which are

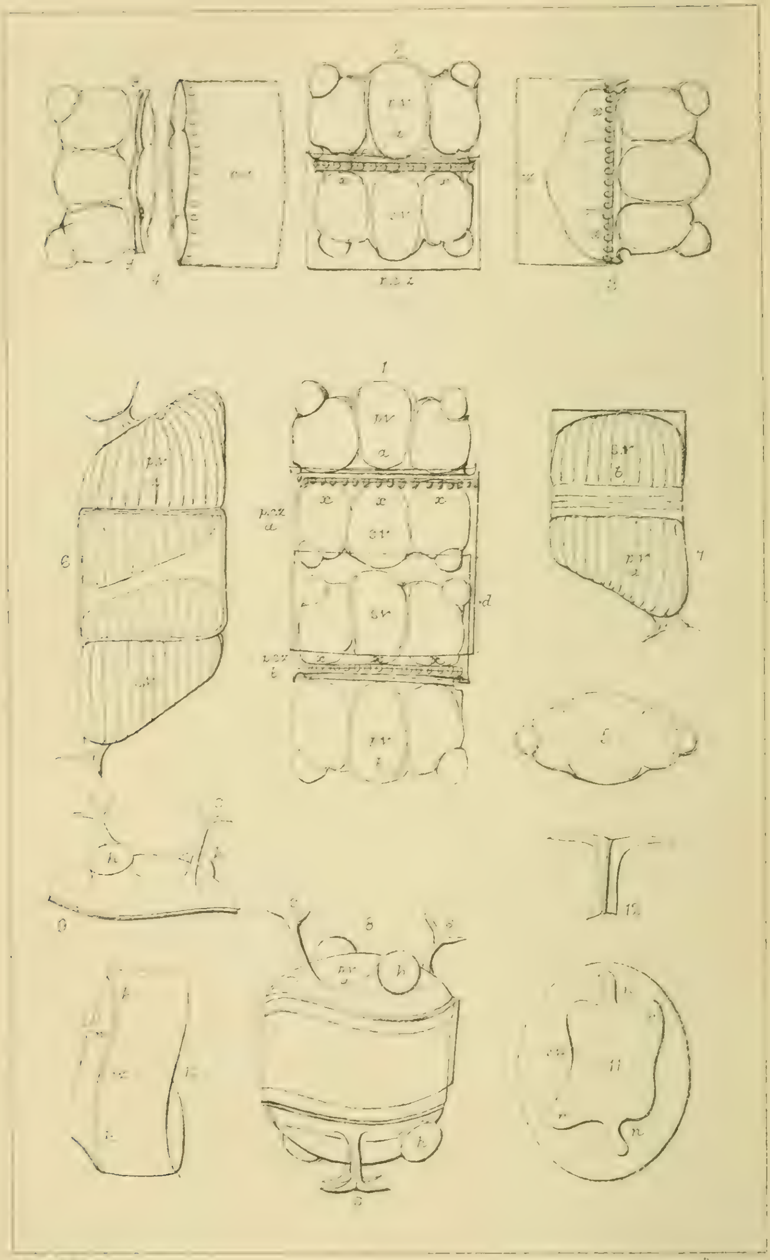
formed by the aggregation of the spores. This fungus is the *Melampsora Salicini* (Lev.) belonging to the order Cæmacei. The sori are scattered, of a bright orange colour in the autumn, becoming dark or nearly black in the winter. The mounted slide exhibits a section of a leaf with the spores *in situ*. These, it will be seen, are crowded into a dense, compact mass, of a bright orange colour. The spores are in many instances globose, in others oblong, and are filled with granules. The sample I send you is but one of very many varieties of leaf-fungi to be found at the present time throughout the valleys of California.

Apropos of funguses and the many forms assumed by them in their development, which are noticeable to even the most casual observer, that of the Phalloideæ is, perhaps, the most marked, though rare. Mr. Kinne exhibited one found by Dr. Wythe in Oakland, growing in the open lawn, though their usual habitat are woods and hedges. This fungus, which is highly poisonous, was identified as *Phallus impudicus.*

The regular meeting was held on November 16, and, in the absence of the President, Mr. Chas. W. Banks was called to the chair.

To the cabinet Mr. Ewing donated a quantity of washed Richmond diatomaceous earth, and also a large lot of the raw Maryland diatomaceous earth for mounting.

There being no written communications, the evening was devoted to the examination of Mr. Banks' donation and various objects.



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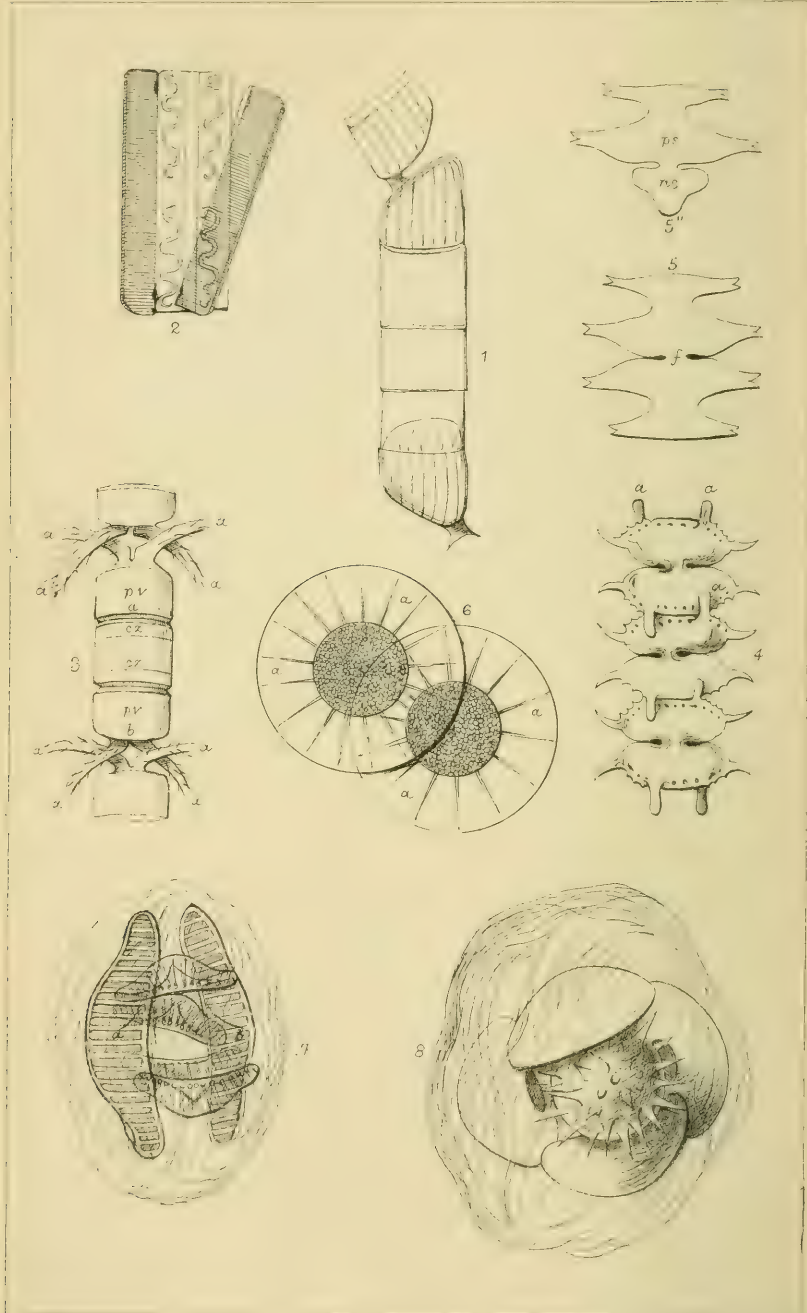

G. C. Wallich del.

W. West & Co. imp.

THE

MONTHLY MICROSCOPICAL JOURNAL.

FEBRUARY 1, 1877.

I.—*On the Relation between the Development, Reproduction, and Markings of the Diatomaceæ.* By G. C. Wallich, M.D., Surgeon-Major, Retired List, H.M. Indian Army.

(*Read before the* Royal Microscopical Society, *January* 3, 1877.)

Plates CLXXI. and CLXXII.

At the close of a paper "On the Structure and Development of the Diatom Valve," laid before the Royal Microscopical Society in December 1859, I drew the following conclusions from certain facts referred to in that and a prior paper "On *Triceratium*," in which the same points had been incidentally discussed by me:

"That the growth of the diatom valve ceases entirely, either at the period of its liberation from the connecting zone of the parent valve, or immediately afterwards."

EXPLANATION OF PLATES CLXXI. AND CLXXII.

Plate CLXXI.

(N.B.—The figures in these Plates are, to a certain extent, diagrammatic; all such markings and details as are calculated to obscure the parts specially under notice having been omitted.—G. C. W.)

Fig. 1.—Two frustules of *Biddulphia pulchella*, in which division has just been completed: *p. v. a* and *p. v. b*, the primary valves of the parent frustule; *s. v.*, *s. v.*, the two secondary or newly formed valves; *P. c. z. a* and *P. c. z. b*, the connecting zones of the parent valves; *d*, the double or overlapping portion of the connecting zones; *x*, *x*, the marginal row of puncta of the connecting zones.

Fig. 2.—A frustule of same, with the connecting zone of the primary valve of the parent frustule still adherent.

Fig. 3.—A primary or parent valve, within the connecting zone of which the new valve is being developed by gemmation.

Fig. 4.—A similar valve and its connecting zone separated from each other: *g*, the deep groove or channel encircling the free margin of the valve, into which the inverted edge of the connecting zone dips.

Fig. 5.—A valve of same, showing the buttress-like thickenings which give the valve of this and some allied species of *Biddulphia* the appearance of being divided into *loculi*.

Fig. 6.—A frustule of *Isthmia nervosa*, in which division is about three parts completed: *p. v. a* and *s. v.*, primary or parent, and secondary valves.

Fig. 7.—A frustule of the same in which division is completed. The connecting zone of the parent valve still adherent, within which the secondary or new valve *s. v. b* was formed. Crossing the centre of the frustule may be seen the two new connecting zones already considerably developed. On their attaining mature dimensions the parent connecting zone generally becomes detached.

Fig. 8.—A frustule of *Biddulphia turgida*, showing the shallow saucer-like valve in this species, with its two horns and two T-shaped spines.

Fig. 9.—A detached valve of same, showing a minute but very definite

"That, subsequently to this period, no change of configuration takes place in the siliceous valve, except along its margin, where fresh secretion of silex may, under certain circumstances, be produced."

"That the *normal* figure of all markings whatever is circular, or approaches thereto."

"That these markings are arranged on the surface of the valve

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marginal rim which dips into a corresponding channel in the circumference of the connecting zones of this species.

Fig. 10.—One of the connecting zones of *B. turgida*, showing the broad bevelled margin which is received *within* the body of the valve; the marginal rim of the latter fitting into the groove *k*, *k*.

Fig. 11.—The connecting zone of *B. turgida* seen from its upper or valvular aspect. The sinuous outline of the bevelled portion is shown, and the two deep notches *n*, *n*, and recesses *r*, *r*, which correspond to the positions of the bases of the spines and horns. (I have been quite unable hitherto to discover what purpose is served by the notches, inasmuch as the spines do not project into the interior of the valve. The presence of the notches would indicate, however, that there is a communication at these points between the interior and exterior of the structure; this supposition being strengthened by the fact that the spines are very distinctly tubular.—G. C. W.)

Fig. 12.—One of the T-shaped spines more largely magnified to show the two orifices of its tubule.

Plate CLXXII.

Fig. 1.—A frustule of *Isthmia enervis* from the middle of a filament, showing the great depth occasionally attained by the connecting zones of this species even before the new valves have been developed to any considerable extent. (This figure is copied from plate xlviii. of Professor Smith's 'Synopsis of the British *Diatomaceæ*.')

Fig. 2.—A frustule of *Grammatophora serpentina*, showing the two connecting zones; the right-hand valve having become separated by accident.

Fig. 3.—A frustule of *Chætoceros* (from the Indian Ocean), showing the connecting zones *c. z.*, *c. z.*; and *a*, *a*, the alternately crossing awn-like processes (abruptly cut off in the figure) by which the frustules are held together in filament.

Fig. 4.—A portion of a filamentous Desmid from Lower Bengal, viz. *Onychonema uncinatum* (Wal.), showing the same kind of alternate crossing of the horn-like processes as has just been referred to in *Chætoceros*. It may be said to be a common character in certain filamentous species both of the *Diatomaceæ* and *Desmidiaceæ*.

Fig. 5.—A frond of *Micrasterias pinnatifida*: *f*, the constricted portion between the two segments.

Fig. 5″.—*a*, a segment of the same which has separated from its fellow by the ordinary process of division; the new segment *n. s.* being developed by gemmation from the constricted portion.

Fig. 6.—The two valves of a frustule of *Coscinodiscus Sol* (Wal.). This beautiful diatom is figured for the purpose of showing the remarkable hyaline and membrane-like ring which surrounds each valve; the ray-like processes being given off from, and probably secreted through, the minute apertures which are present around the margin of the valve.

Fig. 7.—Two "Sporangial Frustules," *a* and *b*, of an *Epithemia*, formed by the fusion of the endochrome of either two or four normal frustules. The empty normal frustules and large sporangial frustules which contain the germs of the new generation being retained within the gelatinous mass, which becomes a *nidus* for the new brood as soon as it is set free from the sporangial frustules.

Fig. 8.—The "Sporangium" of a *Cosmarium*, formed, as in the case of the *Epithemia*, by the fusion of the endochrome of two fronds; so that, from first to last, it may be truly said that the processes of Multiplication and Reproduction in the *Diatomaceæ* and the *Desmidiaceæ* are almost identical.

in a determinate *order*, according to the inherent tendency of the species; but that the *ultimate figure* of the markings is due to forces exerted upon the young valve, whilst in a yet plastic state and retained within the connecting zone of the parent valve."

"And lastly, that the variation in size, and in the degree of fineness or coarseness of the markings, is, within fixed limits, dependent on the conditions under which the Sporangial Frustule gives egress to the germs of the new generation; but that the ordinary process of division is, of itself, sufficient to bring about great variation when operating through a long succession of individuals."

In the course of my observations, I endeavoured to show why variation in the size and markings of different individuals of the same species is not only consistent with, but naturally follows from the evidence which was adduced. That whilst the *total* number of striæ upon a valve may remain nearly uniform in every valve of the same species, the number of striæ upon the fractional part of a valve (say the $\frac{1}{1000}$th part of an inch) admits of just as much variation as the size of the valve, and proceeds simultaneously with it during division, but not afterwards. That, in all likelihood, the internal dimensions of the connecting zone, by which the young or new valve is protected during its secretion and consolidation, determine the size to be attained by it; and although the valve may subsequently receive some additional siliceous deposit, the *whole* of its characters, as we see them in the microscope, are indelibly impressed upon it before or immediately after its liberation. And further, that each of the *two* connecting zones, which (as had been pointed out in my paper "On *Triceratium*") enter *invariably* into the formation of every diatom frustule, increases in depth by secretion of fresh siliceous matter at its free margin *only*; being "thus enabled to slide the one within the other, telescope-fashion, to accommodate itself, with its fellow, to the increase of the cell-contents during division; this feature being most strikingly manifest in such genera as *Biddulphia, Amphitetras, Isthmia*, and others."

In the observations now about to be made, and which form, as it were, a supplement to those just cited, I propose to bring together for critical examination any new facts and deductions on the subject that may have been since then published. I would, however, mention at the outset that although I still adhere, in every material respect, to my old convictions on the question of "markings," it is neither my intention, nor does the scope of this paper demand that I should, on the present occasion, allude to it further than by indicating how far the markings are the result of constantly or inconstantly acting forces.

The first thing to be done is to show clearly what are the

opinions at the present time entertained by the principal writers on the *Diatomaceæ*, upon the questions about to be discussed. This done, it shall be my endeavour—1. To denote the extent to which the conditions invariably attending the development of every new or "secondary" valve of a frustule that has once undergone the process of division may operate in modifying its proportions and its markings. 2. To supply some missing links in the history and actual functions of the "Sporangial Frustule." And lastly, to inquire briefly how far any modifications, engendered by any or all of these combined causes, can be regarded as detracting from the value of the diatom valve as a *definite* and trustworthy "test" of the defining power of microscopic objectives.

In the 1875 edition of the 'Micrographic Dictionary' (p. 238), it is stated that the frustule of the *Diatomaceæ* consists of two usually symmetrical portions or valves, which are in contact at their margins with an intermediate piece, *the hoop*, variable in breadth according to age, &c., and, when very narrow, forming a mere junction line, which is called the line of suture. In some, this hoop is a simple filament; in others, it is broad and marked like the surfaces of the valves; whilst in others, again, the hoops are arranged like the leaves of a book, each with a round or oval aperture in the middle, so that the cavity of the frustules is divided into loculi, and the frustules themselves are to be regarded as compound. During division the hoop undergoes an increase of width, and thus removes the two valves to some distance apart.* *Sometimes* the hoop consists of two pieces, one overlapping the other. The valves of *Melosira* and *Isthmia* are described as gradually separating from each other during division, and *remaining connected* by the simultaneous widening of the hoop. The history and ultimate fate of the hoop seem to be variable. Sometimes it becomes solidly silicified, but not much expanded in breadth, and falls off when the two frustules are complete, allowing them to separate; this being the case in *Gyrosigma* (*sic*), and probably in all the allied forms. Perhaps the most remarkable development of the silicified hoop occurs in *Biddulphia*, *Isthmia*, and similar forms; the new half-frustules, formed inside the hoop, *slipping out from it like the inner tubes from the outer case of a telescope.* In *Melosira*, the hoops appear to keep the new frustules united for some time.

* It will be hereafter shown that the process is strictly the converse of that which is here described, namely, that the siliceous *valves* are forced asunder by the increase of their soft contents during the progress of division, each of the connecting zones being of course drawn back by the valve to which it is adherent; but, when the separation of the two parent valves becomes extreme, the connecting zones each increasing by the secretion of fresh siliceous matter at their free overlapping edges, as before described. Of course, therefore, it is an error to say that the valves of *Melosira* and *Isthmia*, or any other genus, remain connected through the simultaneous widening of "*the* hoop."—G. C. W.

In the latest (1875) edition of Dr. Carpenter's treatise 'On the Microscope' (p. 307), the description of "*the hoop*" is, in every respect, essentially the same as that just quoted from the 'Micrographic Dictionary.' But the author adds that, as soon as the newly formed frustules begin to undergo any increase, "*the valves separate from one another, and the cell-membrane, which is thus left exposed, immediately becomes consolidated by silex, and thus forms a sort of hoop.*" Indeed, so evidently is this portion of the structure still regarded by Dr. Carpenter as single, that, whilst in the letter-press describing the woodcut of *Biddulphia pulchella* (at p. 313), no allusion of any kind is made to the double nature of the connecting zone, the characteristic nature of the appearances presented by the overlapping margins have been very fairly depicted by the artist. The same singular oversight is repeated with regard to the distinct appearance presented by the overlapping zones in the woodcut of *Grammatophora serpentina* (at p. 323), a diatom in which, considering its comparatively small size, the true composition of this portion of the structure is very readily discernible.

"In *Melosira*," Dr. Carpenter continues, "and perhaps in the filamentous species generally, the hoop appears to keep the frustules united for some time. This is, *at first*, the case in *Biddulphia* and *Isthmia*, in which the continued connection of the two frustules by its means gives rise to the appearance of two complete frustules having been developed within the original; subsequently, however, the two new frustules slip out of the hoop, which then becomes completely detached, and the same thing happens with many other diatoms, so that 'the hoops' are to be found in large numbers in the settlings of water in which these plants have long been growing."

And finally, Dr. Carpenter mentions that Professor W. H. Smith (U.S.), in the second part of his "Memoir on the Diatomaceæ," published in 'The Lens' (in 1872), regards the Diatomaceæ as siliceous boxes, with one portion (the cover) slipping over another, as in *Pinnulariæ, or with edges simply opposed*, as in *Fragillariæ*. In the formation of the new valve the new part, which slips out from the older, is somewhat smaller, ... the part which slips out carrying away one of the old valves; and by further self-division, the new valve becomes smaller and smaller, as stated by Braun. At this period conjugation takes place, and a return to the normal condition of the original large frustule by the formation of *a Sporangial frustule double the size of the parent frustules* (*op. cit.* pp. 314, 315).

Thus far it has been my particular aim to quote, as nearly as possible in the original words, the opinions expressed in two of the most recently published standard works on microscopic subjects, regarding conspicuous and important portions of the frustular

structure, and still more important, though certainly far less intelligible, vital processes in these organisms, with a view to show how singularly vague and unsatisfactory these opinions are. For the purposes of my argument, it is necessary that I should now, for a time, invite attention to the observations of a distinguished naturalist, whose judgment on questions of this kind, based as it invariably is on patient and conscientious research, must always command respect, even when it does not happen to be altogether in unison with one's own opinions.

In a paper "On the Diatomaceous Frustule and its Genetic Cycle" ('Annals and Mag. Nat. Hist.' January 1869), Dr. J. Denis Macdonald wrote as follows:

"Having consulted the works of various authorities on this subject, I find the views expressed in the writings of Dr. Wallich (particularly in his paper '*On Triceratium*,' vol. vi. 'Quart. Journ. Mic. Sc.' (1858), p. 242; and 'On the Development and Structure of the Diatom Valve,' vol. viii. ibid. (1860), p. 129), most in accordance with my own independent researches. Dr. Wallich appears to have been the first to set forth clearly that the middle piece or 'zone' consists, while the frustule is intact, of two distinct plates, the one received within the other; and that the growth of such plates can only take place at the free margins, or those which are not connected with the valves; and he has also shown how the capacity of the frustule may be augmented, at least in one direction, by the sliding out of the plates or 'rings,' telescope-fashion, to accommodate themselves to the increase of the contents during division. . . . Dr. Wallich, I think very successfully, refutes the idea of a continuous growth of the diatomaceous frustule, the fact being, as he states, that 'variation in the size of the valve and the number of its striæ' (in any fractional part of an inch) 'proceed *pari passu* during the progress of division, but not subsequently.' He admits that 'growth may take place to the extent of new siliceous matter being secreted along the margins of the valve, its depth being thereby augmented;' but he considers it highly probable 'that the connecting zone, by which the young valve is protected during its secretion and consolidation, determines the limits of the dimensions to be attained by it.' He states, moreover, that 'in truth no two valves of the same frustule can be of the same size, for the new valves, being formed within the connecting zones of the parent frustule, must be smaller than these.' This, I should think, is the essential cause of the great diversity of size observable in the frustules of the same species being constant and universal. . . . It stands to reason that as the two new half-frustules are developed endogenously, or within their parents, the former must be smaller than the latter by the whole thickness of the siliceous investment; and this will continue to be the case

gradatim in the direct line of descent, though of course all the pullulations successively taking place in the same half-frustule will be uniformly of the same size, holding the relation of cast to mould with respect to their developing cell. Seeing, therefore, that the smaller the frustules of the same species are, the more endogenous developments must have preceded them, and, therefore, as one would naturally suppose, the nearer must be the fitness for conjugation to complete the genetic cycle, my great difficulty at one time was to know how the frustules of a given species ever regained their original size, or where this gradual diminution should end. But Mr. Thwaites has furnished us with the solution in his important discovery that the sporangial frustule resulting from the process of conjugation is much larger than the parent cells. . . . Mr. Smith, in his work 'The Synopsis of the British *Diatomaceæ*,' p. 26, says that 'the increase in the new valves, though slight, will, however, sufficiently account for the varying breadth of the bands of the filamentous species, and the diversity in size of the frustules of the free forms, without obliging us to suppose that a growth or aggregation takes place in the siliceous valve when once formed.' Yet it is actually within the fully formed valve that the new half-frustule is produced; and if so, it must, as before stated, be smaller than its parent by the whole thickness of the siliceous coat. 'Starting from a single frustule,' Mr. Smith goes on to say, 'it will be at once apparent that if the valves remain unaltered in size while the cell-membrane experiences repeated self-division, we shall have two frustules constantly retaining their original dimensions, four slightly increased, eight somewhat larger, and so on in a geometrical ratio.'" "I am afraid" (adds Dr. Macdonald) "that this doctrine of a geometrical increase in the size of the frustules will not stand the test either of fair theoretical induction or comparison with natural fact; for although there is truth in a gradual diminution, even this does not take place in a geometrical ratio, which, in the nature of the case, can only apply to number, not to size."

In my paper "On *Triceratium*," to which allusion has already been made, I pointed out that in this and many other genera the connecting zones, which consist invariably of *two* pieces, at first entirely overlap each other, but as the process of division advances, recede from each other, and whilst receding have the appearance of three distinct annular portions or rings, the central portion being less diaphanous than the portion on either side, and its markings confused, owing to its being, in reality, the overlapping double portion under notice. This appearance has led to great uncertainty and doubt in descriptions of the connecting zone, since, from the transparency of the uppermost layer, the markings on it and the one below are seen simultaneously. In those genera in which

the valves attain a great relative depth, we find not only that the connecting zones are more largely developed, but that the valves are furnished with a constricted rim, or groove, to which the margin of the connecting zone belonging to each valve is attached, as if to afford a more fixed point of resistance from which it may extend itself.

In *Amphitetras* and certain forms of *Triceratium* and *Biddulphia*, I went on to say, the undeviating presence of marginal rows of *puncta* on that part of the connecting zone in close proximity to the suture between it and the valve, proves that the growth of each half of the connecting zone takes place only at the margin farthest from the valve to which it belongs. For, were it not so, the rows of *puncta* would recede farther and farther from the "sutures," as the zones increase in depth, a result which never follows. Growth takes place in both zones simultaneously, the actual extent of the overlapping being dependent on the rate at which the new valves, and endochrome within, happen to be developed. In the newly detached frustules (notably in such genera as *Amphitetras* and *Biddulphia*), one valve, namely, the newly formed one, may still be seen enveloped by the half of the connecting zone of the parent frustule within which it was generated; this half remaining adherent sometimes for a considerable period. I believe that a similar structure obtains in nearly all genera, although more easily traceable in some than in others, owing to their greater size and bolder outlines and markings. It may be thus seen in *Himantidium*, *Odontidium*, *Denticula*, *Eunotia*, *Grammatophora*, *Amphitetras*, *Biddulphia*, *Isthmia*, *Hydrosira*, *Coscinodiscus*, &c. I added, in passing, that the beautifully executed figures in 'The Synopsis of British *Diatomaceæ*' show distinctly the average appearances of all these genera, with exception of *Hydrosira* (which was found by me in Bengal after that work was published); but that the author had evidently failed to recognize either the true structure or important uses of this portion of these organisms.*

Again, in my observations "On the Structure of the Diatom Valve" (1860), I dwelt on the share taken in the secretion of the siliceous valve by the "primordial utricle," though admitting that our knowledge on the subject was singularly meagre. We knew, for instance, that the frustules of the *Diatomaceæ*, like the fronds of the *Desmidiaceæ*, are encased sometimes in a gelatinous investiture; and that, in some genera, this investiture is largely

* It is extremely difficult, sometimes impossible, to demonstrate the presence of the two halves of the connecting zone in the more delicate and minute naviculoid and discoid forms; but I have always succeeded in assuring myself that they are *invariably* present,—in other words, that there is no such thing as a "*hoop*," in the sense of its being *single*.

developed, whilst in others it is not so. But, from the invariable comparative obscurity of the more delicate markings in all, until the siliceous surface is freed from its soft covering by boiling acids, I inferred that all extra-frustular structure is secreted by the "primordial utricle" through the marginal apertures of the valves, *much in the same way that the epiderm of the molluscous shell is secreted by the margin of the animal's "mantle."* Of its highly elastic nature there is abundant evidence, and from its retaining its character unimpaired, it is impossible to doubt its vitality; and we are thus furnished with presumptive proof that the invisibility of the motile and prehensile filaments, whose existence I endeavoured to demonstrate inferentially, must be due to the same causes that enable the subtle gelatinous or membranous elastic film of some forms, as, for example, *Bacillaria paradoxa*, to defy our most perfect optical resources.*

It will have been noticed that Dr. Macdonald fully and ungrudgingly confirmed, on the basis of his own independent observations, all the leading facts and inferences mentioned in my papers of 1859 and 1860. Unfortunately, however, there happened to be two points, which, though almost trivial as touched on by me at the time I wrote, did not quite meet Dr. Macdonald's concurrence when he published his paper of 1869; and these at once assume importance from the fact of his having referred to them in connection with an elaborate hypothesis propounded by him in relation to the *order* of increase of the *Diatomaceæ*—an hypothesis which, if sound, must of necessity have shown me to be wrong on the points referred to; but, if unsound, would only lend them additional corroboration.

To render the arguments more readily intelligible, I will at once state what the two issues really amount to on which Dr. Macdonald and myself seem so materially to differ. Put in the shape of questions, they are:—1. Is each connecting zone, as affirmed by Dr. Macdonald, "not merely connected, but directly continuous with the body of its own valve, and therefore essentially a persistent part of the valve"? Or is it, as I (in common with most other observers) believe, so far a supplementary portion of the valve as to become deciduous on some genera, although more or less persistent in others. 2. Are the extreme differences discernible in the size of the frustules of some species obtained from different localities, or from the same locality in differing seasons, sufficiently and wholly accounted for by the successive diminutions in size resulting from division, as urged by Dr. Macdonald? Or is there sufficient

* For a detailed account of all the evidence on which these conclusions were arrived at, I beg to refer to a paper of mine, "On the Distribution and Habits of the Pelagic and Fresh-water *Diatomaceæ*," published in the 'Annals and Mag. Nat. Hist' for January 1860.

ground for maintaining, as I think we are quite justified in doing, that the idiosyncrasy inherent in the "*Sporangial frustule*," *combined* with the varying material conditions attendant on vicissitudes of climate to which the sporangial frustule is pre-eminently subject, is a main cause of difference of size in the parent frustules of these organisms?

Now with reference to the first question. It is a singular fact that although the connecting zone constitutes a very important portion of the frustular structure, it has by no means received the careful attention to which its characters and uses entitle it in any really natural classification of the *Diatomaceæ;* and nothing probably could show more clearly, therefore, how signally these characters and uses must have been misunderstood.

In 'The Microscope and its Revelations' (p. 304) Dr. Carpenter thus describes the *Diatomaceæ*:—"Like the Desmidiaceæ, they are *simple* cells having a firm external coating within which is included a mass of endochrome whose superficial layer seems to be consolidated into *a sort* of primordial utricle. The *external coat* is consolidated by silex, the presence of which in this situation is one of the most distinctive characters of the group. It is a mistake to suppose that the casing is composed of silex alone. For a membrane bearing all the markings of the siliceous envelope has been found by Professor Bailey to remain after the removal of the silex by hydrofluoric acid; and although the membrane seems to have been presumed by him, as also by Professor W. Smith, to lie *beneath* the siliceous envelope and to secrete this on its surface like a kind of *epidermis*, yet the author (Dr. Carpenter) agrees with the authors of the 'Micrographic Dictionary,' in considering it much more likely *that it is the proper cellulose wall interpenetrated by silex*."

Again:—"The impermeability of the siliceous envelope *renders necessary*" (Dr. Carpenter says) "some special aperture through which the surrounding water may come into relation with the contents of the cell. Such apertures are found along the whole of the line of suture in disk-like frustules; but when the diatom is of an elongated form, they are found in the extremities only. They do not appear to be absolute perforations in the envelope, but are merely points at which the siliceous impregnation is wanting, and these are usually indicated by slight depressions on the surface."

Then referring to the error committed by Ehrenberg and Kutzing, of considering the central and terminal expansions of the median band as apertures, Dr. Carpenter adds:—"There can no longer be any doubt as to the real nature of these nodules. As Professor Smith has justly remarked, 'the internal contents of the frustule never escape at these points when the frustule is sub-

jected to pressure, but invariably at the suture, or at the extremities where the foramina already described exist' " (p. 308).

As thus described, but reckoning from within outwards, this so-called "simple cell" consists:—1, of the cell-contents or general mass of endochrome; 2, of the superficial layer of that mass consolidated into "a sort of primordial utricle"; and 3, of the "proper cellulose wall interpenetrated and consolidated by silex." Whilst we are called upon to believe that, in order to admit of an indispensable interaction between the cell-contents and the medium in which the organism lives, there actually do exist apertures in stated parts of the discoid and elongated genera, but that these are, after all, "*not absolute perforations in the siliceous envelope, but merely points at which the siliceous impregnation is wanting.*"

It is not so stated by the author of the above description, but I presume it is left to be inferred, that the absolutely indispensable relation between the interior and the exterior of this "simple cell" is maintained through the imperforate cellulose membrane at the minute points where the siliceous material is absent, by osmotic or dialytic action.

Such a combination of structure, mysterious as it certainly appears, is no doubt conceivable. But I confess that to my mind it seems so pregnant with incongruity and so incompatible with the simplicity of Nature's ordinary methods of going about her work, as to force on me the conviction that it is in the highest degree improbable. At all events, I venture to say that, by pinning our faith to such a doctrine, we incur the grave risk of sacrificing fact at the altar of mere hypothesis. Nay, even assuming, for the sake of argument, the necessity of the case, as here stated, to be met in the manner suggested; in other words, assuming that the maintenance of the life of the organism may be thus provided for, it neither does, nor can it by any means within our experience, account for all the extra-frustular phenomena presented to us in these humble organisms. It does not, and, what is more, it cannot, account for the movements of the diatom, or the secretion of the gelatinous and, in some instances, highly elastic membrane-like investments which in some are patent enough to our vision, and in others we are perfectly warranted in believing to be present, though as yet we have failed to render them visible. And, to say the very least of it, it is in no small degree perplexing to have to accept as truths the existence of "apertures" that are the moment afterwards said to be no apertures, but only the exposed points of an imperforate cell-wall!

But inasmuch as the day has long since gone by for ignoring the logic of cause and effect, I may be allowed to point with a sense of triumph to the closely analogous case, very recently published in the 'Proceedings of the Royal Microscopical Society,' namely, that in which the long suspected but never before seen

flagellum of *Bacterium* was revealed to human gaze, through the untiring perseverance and skill of Messrs. Dallinger and Drysdale; and to base on this a confident expectation that it is but a mere question of time, and the proper use of the all but perfect optical appliances which our foremost opticians now place at our disposal, when the motile and prehensile filaments of some of the naviculoid diatoms, and the elastic investiture of the mysterious *Bacillaria paradoxa*, shall be also revealed to us.*

There is, however, another point connected with this subject that demands careful notice. Dr. Carpenter, in common, I believe, with every other writer on the *Diatomaceæ*, down to a very recent period, regards the so-called "*hoop*" as a single solid piece formed "*by the consolidation of the portion of the cell-membrane which is left exposed when the valves separate from each other during the development of the new valves.*"†

Now, unless the hoop be really single (which it certainly *is not*), it is evident that, in order to account for the admitted lengthening and simultaneous increase in the overlapped parts which take place in many of the larger filamentous genera *after* the new half-frustules are fully developed, it would be necessary to assume that, altogether externally to the exposed and consolidated surface of the inner of the two connecting zones, there must exist, *somehow*, a second exposed surface of "*proper cell-wall*," which in turn becomes similarly interpenetrated by silex. It seems difficult to understand, however, if this second layer were thrown out, say in the shape of a fold or projected process of the "proper cell-wall," how it could be that when once fairly silicified, this could admit of the least movement either backwards, forwards, or sideways, *over* the already formed inner siliceous layer; unless by taking a third bold leap in the dark, and declaring that, as soon as consolidation was secured, it becomes a detached but nevertheless integral part of the frustular structure.

Dr. Macdonald says (*loc. cit. ante*, p. 3):—"Dr. Wallich seems to consider the hoops of the connecting zone quite supplementary and not essentially persistent parts of the valves themselves, though often easily separated." This—Dr. Macdonald will, I know, excuse me for saying—is rather more than I said, and a good deal more than I, at all events, meant. In speaking of the two zones as deciduous, I had no intention of conveying the idea that I regarded them as merely supplementary or other than highly important

* Moreover, if analogy goes for aught, we have analogous extra-cellular structure ready made to hand, as it were, in the extremely delicate sarcodic investiture of the foraminiferous shell, which was discovered some five-and-twenty years ago by Professor Williamson, of Owen's College, and which I have myself detected as being invariably present in the *Polycystina*, *Acanthometræ*, *Dictyochidæ*, and other testaceous oceanic Rhizopods.

† Carpenter 'On the Microscope.' 1875 ed. p. 307.

portions of the frustular structure. It has never been *my* view, but Dr. Macdonald's, that "*it is actually within the fully formed* VALVE *that the new half-frustule is produced*" (*loc. cit.* p. 4). For then it might with perfect truth be asserted that the connecting zones are a mere surplusage, which they undoubtedly are not. What I maintain is that the new half-frustule is formed *within the connecting zone* of the parent valve. There is not a whit more reason for assuming that the new half of the frond of the just divided Desmid is *formed within* the parent half from which it is poured or budded forth, than there is for assuming that the new half of the diatom frustule is formed actually within the fully formed parent valve. At all events, I can unhesitatingly state that such an anomaly has never been witnessed by me during my somewhat protracted acquaintance with both these families. And I would therefore ask for an answer to this crucial question: If the new half-frustule of *Biddulphia pulchella* or *Amphitetras antediluviana* (two diatoms just now selected by me solely as being the giants of the race) is formed "actually within the parent valve"—taking into consideration the fact that, just within and around the margin of the valves, these diatoms are deeply constricted—how does the infant valve (*after consolidation*, of course) manage to squeeze itself out of the narrow-mouthed cage? Should it be urged that it escapes *before* consolidation is begun or completed, it is clear that the fact is altogether valueless in relation to the question as to *which* part of the structure—the parent connecting zone or the parent valve—determines the dimensions of the new half-frustule. For, in that case, the moment the young pulpy infant escaped from its thraldom, its development *could only be under the dominion of the connecting zone;* a portion of the structure in which, as will be presently shown, certain other most interesting peculiarities are to be found in the genera referred to.

But Dr. Macdonald expresses himself in no ambiguous language on the point, for he says (*loc. cit.* p. 2), "Each of the sliding segments of the connecting zone is, moreover, *not merely connected with but directly continuous with the body of its own valve,* that which is invaginated being always the younger, *having been produced within the other or the parent valve.*" . . . "*Whatever may be the configuration of the true ends of the frustule, or, in other words, the body of the valves, the sides or 'hoops' of the two forming the so-called 'intermediate piece,' are, as it were, marginal extensions of them.*"

In reply to this statement, I venture to say that few persons who have studied the *Diatomaceæ* as a whole will dissent from the opposite view, namely, that the "hoop," be it double or be it single, is deciduous in the majority of the genera. Indeed, as shown in the extracts already adduced, there does not seem to be a single authority, excepting Dr. Macdonald himself, who would maintain that

they are, as a rule, persistent throughout the entire life-cycle of every half-frustule that has undergone the allotted number of divisions. Moreover, I doubt the possibility of the persistence of the "hoop" being *demonstrable* at all, even were we assured of its being a fact. But, fortunately, the determination of this point is quite immaterial in reference to the hypothesis with which Dr. Macdonald associates it.

His hypothesis hinges (if I interpret it aright) on the validity of the assumption that the internal sectional area of the valve, and the hoop belonging to it, are identical.* My impression is that their identity, in the sense implied, of absolute continuity, is by no means a characteristic of the diatom structure.

With the utmost respect for Dr. Macdonald's opinions, it appears to me that he has based his inferences, in this instance, far too exclusively on data supplied by a single group of diatoms; and that, even as regards that group, he has scarcely apprehended the structure correctly. It is true that *Biddulphia* and *Isthmia*, two genera specially examined by him as he tells us (*loc. cit.* p. 1), were amongst those singled out in my paper as offering the greatest facilities for the detection of differences in size between the older and younger valves of each frustule, and for showing most readily and distinctly the overlapping telescope-tube action of the free ends of the connecting zones; the entire frustules being often of such magnitude as to enable us to distinguish the contrast in the external diameters of the two halves arising from the conditions described. But I stated with reference to *Isthmia*—and this, let me observe, is a most important fact in relation to the argument—that, "although we sometimes meet in that genus with great variation in the length and breadth of the frustules growing on the same object" (say an alga), "it would be found that these marked differences do *not* always occur in the same filament, but in separate filaments; and that frequently the primary frustule, or rather that valve of the primary frustule by which adhesion is secured, does not exceed in size the *smallest* of any of the neighbouring terminal frustules." †

But, as my entire remarks at every turn testify, I neither suspected nor did I assume the existence of an inviolable order of decrease such as that propounded by Dr. Macdonald; and for the best of reasons, namely, that the connecting zone of the primary valve in *Biddulphia pulchella* and *Amphitetras antediluviana* so often exceeds, in its diameters, the diameters of the valve itself, as to leave no room for doubt that a secondary or new half-frustule,

* See the passage just quoted, in which Dr. Macdonald describes the *perfect* continuity in substance, and in outline, of the connecting zone and its parent valve.

† "On the Structure and Development of the Diatom Valve," by G. C. Wallich, M.D., 'Quart. Journ. Micros. Science,' December 1859.

though secreted within the connecting zone of the parent valve, may, and actually does, occasionally, excel the latter very considerably in its dimensions.* When it is mentioned (though of this fact I did not apprehend the full significance until I had reaped the benefit of Dr. Macdonald's most valuable observations, eight years after I wrote on the subject) that the diameters of the outermost "hoop" not unfrequently exceed those of its own parent valve, by as much as one-tenth or one-twelfth of those diameters; whereas the thickness of the siliceous wall of the connecting zone is so extremely small as well-nigh to baffle the attempt to measure it at all; it will, I submit, be conceded that there is strong *primâ facie* evidence against the invariable operation of such a law as Dr. Macdonald tries to uphold.

But this is not all. A cursory examination of a series of specimens of the two species of diatoms above named will suffice to explain how (I do not pretend to say *why*) this seemingly exceptional character is so marked in them. In both, immediately behind and encircling the free margin of each valve externally, there runs a deep channel or groove, which consequently projects, on the inner side of the valve, into the general cavity, and materially curtails its sectional outline on that plane. The connecting zone springs, as it were, from the bottom of this channel, then rises perpendicularly to it, until well clear of its border; and then bends abruptly forward at a right angle to form the true *hoop* in each connecting zone. Now so little can the connecting zone in *Biddulphia* be said to be "not merely connected but directly continuous with the body of its own valve," forming (as Dr. Macdonald has it) an exact marginal extension of it; and so prone are several species of *Biddulphia* to ring the changes on this part of their structure, that in *B. turgida* the margin of the valve, which is generally perfectly even and defined, actually embraces and overlaps *externally* the margin of its own connecting zone. In this species the overlapped part of the connecting zone consists of a gracefully bevelled and broad brim, which curtails *its* own sectional outline by as much as one fifth or one-fourth, and abuts against the inner side of the concave saucer-shaped valve; the same result being brought about in *B. pulchella*, by the deep constriction already described, in the margin of the *valve* itself. I would, however, specially direct attention to *B. turgida*, on another ground than the presence of the constriction, which in it is very shallow; namely, in relation to its at once disposing of Dr. Macdonald's idea that the

* It is a noteworthy proof of how often the keen eye of the artist is keener than the keen mind of the scientific investigator whose researches he is illustrating, that in many of the figures in Smith's 'Synopsis' and in Dr. Greville's papers on *Diatomaceæ*, this and other existent niceties of structure are faithfully portrayed.

newly formed half-frustule could possibly, in its case, be fully developed *within* the body of the parent valve, or even that it could be secreted in the pulpy state within it. A glance at the admirable figure of this diatom in 'The Synopsis' will at once confirm this view.*

A similar configuration, but even more conspicuous, may be observed in *B. regina* and *B. Tuomeyii* (a variety of *B. regina*). In *B. Baileyii* the frequent extension of the connecting zones considerably beyond the extreme point occupied by the faces of the newly formed valves is very marked. But in this species, as in *B. turgida*, the constriction is slight, though sufficiently distinct to be easily perceptible. Amongst the rarer filamentous genera showing these characters strongly, may be mentioned *Dicladia* and *Chætoceros*. Indeed, were it not that the presence of the connecting zone in every diatom furnishes us with a character which is almost infallible, the true affinities of these two genera might remain doubtful. The same may be said of *Rhizoselenia*, in which I detected the connecting zone, but with considerable difficulty, owing to its extreme attenuation, and only in the uncleaned state.

As a matter of fact, there is a constriction or notch, into which the inflected rim of the connecting zone is received, present in probably every diatom, though much more difficult of detection in the minute elongated and tabular forms. Everyone who knows the *Diatomaceæ* is acquainted with the appearance presented in the front view of their frustules, at the four points or angles where the connecting zones are in contact with the valvular margin. The *notch* always visible in that position is in reality a profile view, at that point, of the groove and the inflected rim of the connecting zone that fits into it, being totally distinct from the lateral view of the terminal nodule which holds a neighbouring position. Here again I would invite attention to the figures in 'The Synopsis,' as admirably depicting the structure.

I must here allude incidentally to a very important fact connected with the extra-frustular appendages of the diatom, viz. my having found that the *principal* spines (not the *cornua*) on the valves of some *Biddulphiæ*, and the spines forming the elegant coronet on those of *Creswellia, are tubular*. In this respect they resemble sponge spicules. But it can be at once seen in *B. turgida* that these spines, instead of being secreted in concentric films around the longitudinal core or axis (which is the invariable mode of growth in the siliceous sponges), are perfectly homogeneous, and in this respect assimilate with the *Polycystina*. In *B. turgida*

* My observations on these big diatoms were chiefly made at Guernsey in 1858, where they are to be found at depths ranging from half low-water mark to eighteen or twenty fathoms. I was gratified to find, whilst this paper was being drawn up, only a few days ago, that the characters referred to are admirably shown in 'The Synopsis'; notably *B. turgida*, also a Guernsey diatom.

the two principal spines are T-shaped, the base of the T being attached to the valve; and the tubule (which may be very distinctly seen in the larger specimens) having its external opening immediately at the top of the stem of the T, and *not* bifurcating so as to open at the two extremities of the cross-bar of the T, as would be the case in any sponge spicule. There is strong evidence in support of the view that, through these tubules, a communication is established either with the surrounding medium, or, in some filamentous genera, with the corresponding spines of adjacent frustules. Indeed, in *Creswellia* the extraordinary fact presents itself that every one of the large series of spines forming the coronary circlets is precisely in apposition with a similar number of spines in the adjacent frustules. And from the circumstance of the spines not being tapered but cylindrical, and, if anything, slightly inflated at the points of union with the adjacent spines, they very closely resemble in appearance, and are in all probability identical in function with, the horny-looking processes met with in some of the filamentous *Desmidiaceæ*.* I mention these morphological resemblances because the more I look into the structural details of the *Desmidiaceæ* and *Diatomaceæ*, the more closely do I find that they agree on all points apart from the degree of consolidation, and the nature of the substance producing the consolidation, of their enveloping wall. By far the most important proof, however, of the close relation between these two families has yet to be submitted, when I come to treat of the "sporangial frustule."

Before passing on to the next section of my subject, I have to draw attention to an observation of Dr. Macdonald's, which certainly appears to me to involve more than he intended—an observation which, if correct, would form an immovable keystone to his hypothesis; but if incorrect, as I believe it to be, cannot fail seriously to mislead. He says (*loc. cit.* p. 3), "It stands to reason that as the two new half-frustules are developed endogenously, *or within their parent*, the former must be smaller than the latter by the whole thickness of the siliceous investment," &c. &c. And again (p. 4), "Yet it is *actually within* the fully formed valve that the new half-frustule is produced; and if so, it *must*, as before stated, be smaller than its parent," &c. &c.

I venture to affirm that the new half-frustule is *never* developed within the fully formed or parent valve at all; and that it is invariably developed as an outgrowth from the soft contents, entirely beyond the free margin and plane of the parent half-frustule; precisely as the new segment of the *Desmid* is developed

* The close resemblance here referred to may be well seen on comparing the figures of *Creswellia*, on the one hand, and *Streptonema* on the other, appended to Dr. Greville's "Description of New and Rare Diatoms" (' Q. J. M. S.' Jan. 1864), and my papers on "The *Desmidiaceæ* of Bengal" (' Annals and Mag. Nat. Hist.' ser. 3, vol. v. plate viii. fig. 1).

as an outgrowth from the parent segment. In all my experience I have never seen a new half-frustule so developed; nor do I believe such an occurrence to be possible; for, from the very outset, there is a "suture line," and this suture line is nothing more or less than the embryo connecting zone, which is not a subsequent interpolation, as it were, but a simultaneous product with the development of the new valve itself. And, if so, whenever the parent connecting zone exceeds its own valve in diameter (as I have shown to be the case frequently in some diatoms), there is, of course, an end to Dr. Macdonald's deduction from the premisses, namely, "that the newly formed half-frustule *must* be smaller than the parent valve, by the whole thickness of the siliceous investment, and that this will continue to be the case *gradatim* in the direct line of descent, through the course of all the pullulations taking place successively in the same half-frustule."

Should further proof be desired of the impossibility of the parent valve forming a "mould" within which the new valve is, as it were, cast, it will I think be found in the significant fact that in several well-known genera of Diatoms, the two valves constituting each frustule are never symmetrical, *except* in sectional outline where each margin is in connection with its own connecting zone; the symmetry in this region being obviously essential to admit of one of the connecting zones slipping accurately (as before described) over the other. We are thus furnished with what appears to me to be conclusive evidence that there resides in the endochrome of these organisms, an inherent and hereditable formative power of a determinate kind, though by no means so determinate as the force which governs the formation of every crystal. At the same time it appears certain that accidentally caused deviation from the normal form may be handed down, in direct descent, from the frustule in which it first originated. But it must be borne in mind that this does not take place unless the mechanical or other cause has acted on *the connecting zone.* Thus it not unfrequently happens that a sinuosity, or a notch, may be found in a large number of specimens of a species of diatom collected in one piece of water, whereas not a single example of it is to be met with in specimens collected in another piece of water in the same neighbourhood.

Reproduction.—In the Introduction to the second volume of 'The Synopsis of the British *Diatomaceæ*,' the late lamented author of that work prefaced a brief account of the "sporangial frustules" of certain species with the characteristically candid admission that, during the three years which elapsed since the publication of the former volume, no new light had been thrown on the subject of reproduction, and that the entire process was, in short, "too imperfectly understood."

Nearly twenty years have since passed, and yet, strange to say, these words might with almost an equal amount of truth be now re-echoed. If this fact is to be regarded as a source of regret in one sense, it becomes, at all events, a source of congratulation in another, since it enables me to dive at once into any new matter that I may have to communicate on the subject.

Unless a number of significant facts, which have come under my notice in various parts of the globe, and have one and all seemed to point to the same conclusion, have been wrongly interpreted, an extraordinary misapprehension has, from the very outset, attached to the conception of what the so-called "*Sporangial Frustule*" of the *Diatomaceæ* really is; and to this misapprehension may, in all probability, be ascribed the failure on the part of observers to detect the sequence of results which they looked for as the natural outcome of a preconceived, but (as I with all submission conceive it to be) a faulty theory.

If my idea is correct, the sporangial frustule, instead of being, as heretofore assumed, the primary or parent frustule of a new and vigorous generation, constitutes, in reality, the expiring phase in the life-cycle of a generation that is passing away. In short, it is nothing more or less than the homologue of the "Sporangium," that is to say, the Sporangial CELL of the *Desmidiaceæ*, which contains and, for a time, shelters the germs of the coming generation; but is itself doomed, on the liberation of its living contents, to death and immediate decay. So that here, as in almost every other point, the close resemblance in organization, and in the methods by which the Nutrition, Multiplication, and the Reproduction of these two families of Protophytes are carried on, seems at every step to be more and more firmly established. And I need hardly point out that the term "sporangial frustule" becomes in this case only the more appropriate, since we must regard the monster frustules, with all their palpable eccentricities of shape and marking, *not* as the parent frustules of a new generation multiplying directly by division from it, but as an intermediate frustular condition, produced, of course, from the fusion of the cell-contents of a varying number of normal frustules (as described by writers) and, as before stated, constituting the homologue of the sporangial cell of the *Desmidiaceæ*. (See back, para. top p. 63.)

My limits will not admit of my now furnishing a detailed description of the facts on which this conclusion is based. Suffice it to say that the facts are numerous, and as conclusive as any facts can be which it is practically impossible for us to trace out from first to last, as we can in the case of the Monads and Infusoria. In these the entire reproductive processes are sometimes begun and completed in as many hours as they occupy days in the *Diatomaceæ*. Mr. Smith, in 'The Synopsis,' speaks of twenty-four hours as a likely

period in the latter. According to an American writer in 'The Lens,' whilst the process of fission in the soft parts of the diatom occupies only from fifteen to twenty minutes, the development of the valve occupies six entire days. My belief is that even this is an under-estimate. I need hardly point out, therefore, how greatly enhanced must be our difficulties in attempting to follow with our eye,—1, the fusion of the endochrome of the frustules which unite in forming the sporangial mass or masses; 2, the gradual development out of those masses of the sporangial frustule or frustules; 3, the investiture of the sporangial frustules with the gelatinous *nidus* in which they for a while rest; and lastly, the liberation from the sporangial frustules, whilst still retained within the *nidus*, of the true germs which shortly become the true parent frustules of the "coming race."

For the present I must content myself with stating that the sporangial frustule is always more or less of a monster, both as regards dimensions* and outline; rarely, if ever, presenting the symmetrical outlines so characteristic of these graceful organisms; that it is rarely, if ever, perfectly silicified; that the bloated expression it exhibits is never handed down, as would inevitably be the case, were it the model upon which the new brood is formed; and lastly, that I have never seen the slightest semblance of division in it, by the formation of two new valves. On the other hand, such incongruous characters are occasionally to be seen in the sporangial frustule whilst still in the embrace of the siliceous valves from which it sprung, as to engender a suspicion that it may be a Diatomacean cuckoo that has walked into its neighbour's nest.

But from the *contents* of these giant frustules the new parents of the race arise:—first, in the shape of minute masses of nucleated endochrome; these masses enlarging gradually in size till they attain the normal (but never exaggerated) proportions and outlines of the species to which they belong; finally becoming endowed with their siliceous investiture; and *then*, but not till then, earning the name of parent frustules. I leave it to Sir James Hannen to decide how far his judgments coincide with the fact that even before the honeymoon of the two parent valves of the diatom is over, they part company for ever, and if by the force of fate compelled to retain some bond of union, as witnessed in the filamentous species, they take the precaution of at all events placing their children and children's children, even unto the fiftieth generation, as buffers between them!

But although the true parent frustules are never monstrous (in the sense of being specially created because Nature is impotent to restrain the gradual degeneration in size, upon which so much stress has been laid, and to make amends for which so much brain

* It sometimes is twice or even thrice the size of the largest normal frustule!

power has been expended), there cannot be a doubt that the new brood may vary very considerably in its dimensions. And it is here, and *here only*, as I clearly pointed out (though Dr. Macdonald no doubt quite unwittingly misunderstood my words), that "vicissitudes of season" come into operation. It is, I believe, true, that mere climate has little if anything to do with the matter. I have found almost as exuberant growths of *Desmidiaceæ* in Greenland and Labrador, as in the Tropics. It is the extreme and sudden vicissitudes of heat and cold, of drought and deluging rain, that are the chief modifying agents which tell upon the expectant Sporangia. And even in the sub-arctic lands referred to, such vicissitudes occur, for during a very few hours of the brief summer day the heat is sometimes actually excessive.

Taking all these circumstances into due consideration, I venture to submit that from the birth of the diatom to its death, influences are at work which are, at all events, more than sufficient to render that mathematical uniformity in the markings of the diatom valve impossible, which is an essential condition if they are to be used as test-objects. And I would therefore sum up my observations on this portion of my subject by repeating one of the opening paragraphs of my paper "On the Markings of the *Diatomaceæ* in common use as Test-objects," published in 'The Annals and Mag. Nat. Hist.' for February 1860:

"Certain diatoms may still be advantageously employed as test-objects, but assuredly not in the manner hitherto in vogue. In order to ensure uniformity, or, what amounts to the same thing, to ensure that the purchaser of a lens of a stated power shall actually obtain what he desires, it becomes essential that each test-slide should itself be first compared with some accredited and universal standard, before being applied for determining the capabilities of any optical combination."

II.—*Observations on Professor Abbe's Experiments illustrating his Theory of Microscopic Vision.*

By J. W. Stephenson, F.R.A.S., Treasurer R.M.S.

(*Read before the* Royal Microscopical Society, *January* 3, 1877.)

Plate CLXXIII.

In my opinion, the very important theory of microscopic vision which has been enunciated by Professor Abbe,* has not received, in this country, the attention it pre-eminently deserves. The theory to which I refer, is, that the microscopic images produced by certain objects of minute detail, such as diatoms, scales of insects,

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EXPLANATION OF PLATE CLXXIII.

Fig. 1.—Fine grating used as the object on the stage of the microscope.

Fig. 2.—Appearance presented on removing eye-piece and looking down tube, showing central and spectral images.

Fig. 3.—Diaphragm with three slits in position, shutting out certain spectral images, and making those produced by coarse and fine lines identical.

Fig. 4.—Appearance presented on examination of object (Fig. 1) when examined under the latter condition; fine lines in normal condition, coarser doubled in number.

Fig. 5.—Diaphragm excluding *all* the spectral rays from finer lines, and all except the two adjacent to central beam from the coarser lines.

Fig. 6.—Shows the coarse striæ alone; the finer invisible in consequence of all their spectra being excluded.

Fig. 7.—Diaphragm excluding *all* spectral rays.

Fig. 8.—No lines visible in consequence.

Fig. 9.—Diaphragm excluding all the spectra of Fig. 2, except the fourth of the coarse and second of fine grating.

Fig. 10.—Appearance presented; coarse lines quadrupled and fine lines doubled in number.

Fig. 11.—Effect produced by light of extreme obliquity on parallel lines of such fineness as to have nearly reached the limit of resolvability; the illuminating pencil at the edge of field, and only the more refrangible rays of spectral image remaining in the field at the opposite side.

Fig. 12.—Appearance presented in tube by single valve of *P. angulatum*; light central.

Fig. 13.—Fine crossed grating (60°) used as object on stage of microscope.

Fig. 14.—Spectral aspect produced by crossed grating; the spectra within smaller circle identical in form with *P. angulatum*, Fig. 12.

Fig. 15.—Diaphragm in position admitting central beam and three spectral rays; the imaginary lines joining them crossing each other at right angles.

Fig. 16.—Appearance of Fig. 13 under these conditions; the lines crossing each other at right angles at distances inversely to those of the spectra ($\sqrt{3} : 1$).

Fig. 17.—Square grating.

Fig. 18.—Appearance presented in tube.

Fig. 19.—Diaphragm admitting central and one spectral image.

Fig. 20.—Consequent disappearance of all real lines, and substitution of diagonal lines at right angles to admitted rays.

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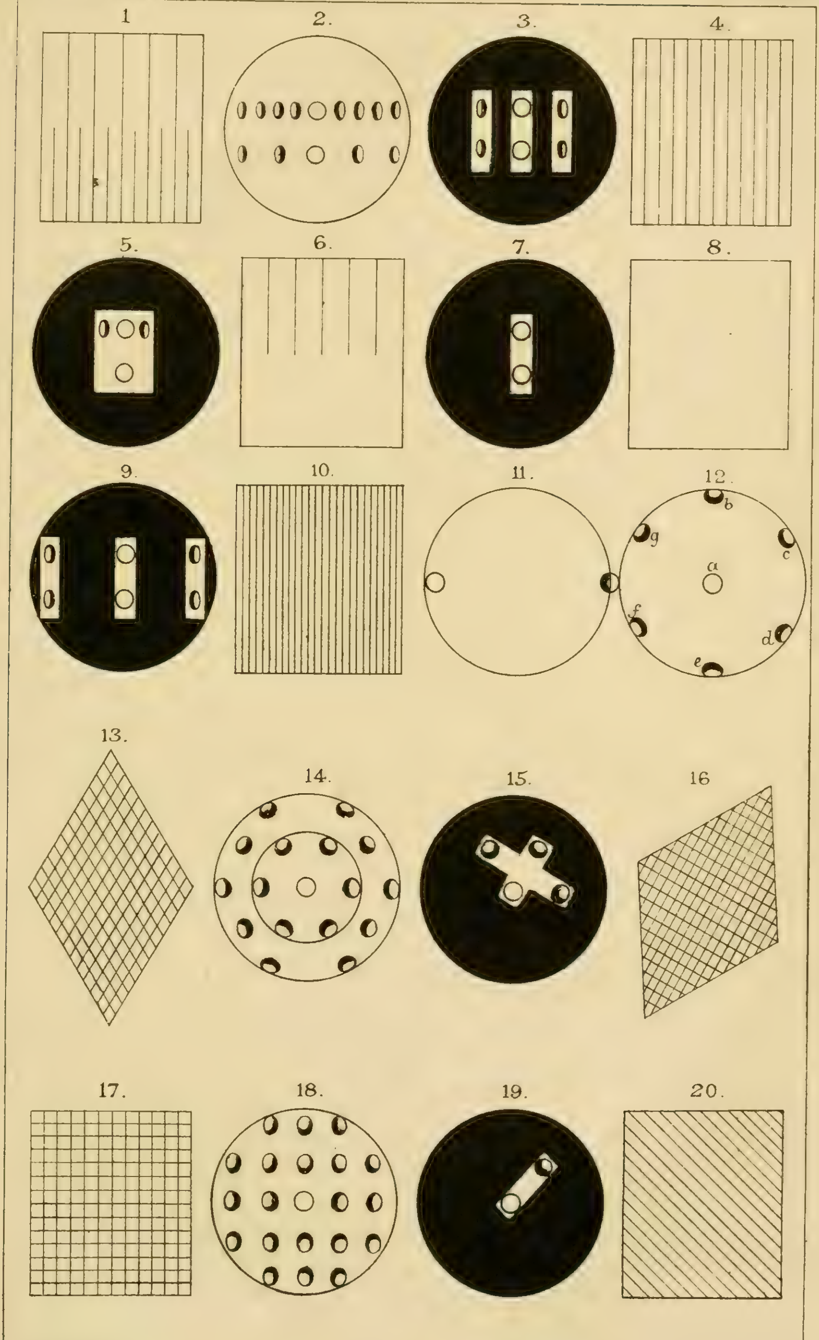
* A valuable translation, by Dr. H. E. Fripp, of Professor Abbe's "Contribution to the Theory of the Microscope, and the Nature of Microscopic Vision," appeared in the 'Proceedings of the Bristol Naturalists' Society,' new series, vol. i. part 2.



C. Stewart del. W. West & Co lith.

and other things, are not simply direct dioptrical images, such as the mere outline of an object, but are the result, in most cases, of the combination, or fusion together, of the central pencil with certain secondary images, produced by the *interference* of those pencils of light, into which, by diffraction, the incident beam of light is, in passing through the object itself, resolved; in other words, that the principal or central beam of light *alone* is not sufficient truly to depict fine lines, small apertures, or other minute structural details, but that, as far as resolution is concerned, two or more pencils are always necessary to produce the desired effect. These pencils may, or may not, include the principal or dioptric beam, but where the latter is excluded the image necessarily appears on a dark field.

Further, his contention is, that when from any cause whatever, whether from the angles formed by the intersection of lines or the closeness of the lines themselves, whether from the aperture of the object-glass, or when, by artificial means, the diffraction images, as seen within the body of the microscope, are made similar, the microscopic images themselves will be identical.

The diffraction images of a lined object, in focus on the stage of the microscope, may readily be seen by removing the eye-piece and looking down the tube of the instrument. Here, with the light central, and the lines on the object parallel, the coloured spectra are distinctly visible, going off on either side at right angles to the direction of the striæ, the most refrangible rays next to the central beam of light. The latter fact is particularly mentioned, as it has an important bearing on the limits of visibility and on the photographic reproduction of microscopic objects.

Professor Abbe has supported his views by some very striking experiments, which appear to me to be a complete practical demonstration of the truth of his mathematical deductions; and by his permission, I propose to exhibit under the microscope this evening four or five of those which impress me as being the most important, and therefore the most interesting.

1*st Experiment.*—The purport of the first experiment is to illustrate the production of *identical* microscopic images by *different* structures, when, by artificial means, the diffraction pencils arising therefrom are made similar in number and position, within the tube of the instrument, as previously mentioned.

This experiment is made on a grating formed of alternately long and short parallel lines (Fig. 1), ruled with a diamond through a film of silver, of extreme tenuity, deposited on the under side of a thin glass cover, and subsequently cemented with balsam to an ordinary glass slip, the coarser lines being about 1790 to the inch, and the finer about 3580.

This grating gives rise to two sets of diffraction spectra, when

placed beneath the objective, in the middle of the field, the set arising from the wider portion, being *exactly* half the distance apart of that arising from the narrower, such distances between the spectra, being inversely proportional to the distances between the lines themselves.

On removal of the eye-piece these two rows of spectra (Fig. 2) are visible, one above the other, as the eye is brought to see successively the air images at the upper end of the tube.

It is obvious, from the figure, that as the wider grating gives spectra *exactly* half the distance apart, and therefore twice as numerous as those arising from the narrower, that the latter may be made to coincide with the former, in number and position (as required), by stopping out every alternate ray from the wider grating, beginning with the first.

This is readily accomplished by placing a stop close to the back combination of the objective. so constructed that a central slit will admit the central ray only, whilst another slit on each side will admit only the second spectrum of the wider and the first spectrum of the narrower grating (Fig. 3).

On replacing the eye-piece it will now be seen that the microscopic image of the narrower lines remains unaltered, but that the wider lines have doubled in number (Fig. 4), by an apparent prolongation of the shorter lines between them, making the two images identical, the upper part being distinguishable only from the lower by somewhat less brightness, which simply arises from the smaller number of real lines through which the light can pass.

Again, by stopping out all the spectra, except the fourth of the wider, and the second of the narrower (Fig. 9), the spectral aspect is again rendered similar in the two cases, and the microscopic images, though changed, will be still found to be identical, by the doubling of the narrower and quadrupling of the coarser lines (Fig. 10); but to see this distinctly, with so low a power as Zeiss' *a*, *a*, the fifth, or E, eye-piece is required.

I should state that, although in this experiment a Zeiss *a*, *a*, with a third eye-piece, has been used, any other object-glass of about 1 or 2 inch focus would do as well with a suitable stop; the stop used with the objective mentioned in this experiment has three slits, each $\frac{1}{20}$ of an inch wide, with the same distance between them.

2nd Experiment.—In this experiment the same grating is used as before, with a diaphragm having a single central slit, so adjusted (parallel to the lines of the object) that one spectrum only will be admitted on each side, from the coarser grating, and none whatever from the finer (Fig. 5); the object of the experiment being to show that unless one spectrum at least is admitted there is no power to resolve the lines.

An examination by the eye-piece shows that this is so; by the reduction of the aperture the finer lines (the spectra of which are excluded) have disappeared and been replaced by a plain silver band, the coarser lines appearing in their normal condition, as anticipated by theory (Fig. 6).

3rd Experiment.—This experiment, like the former, illustrates the necessity of an amount of angular aperture sufficient to admit some spectral rays; in it the central slit is simply reduced to $\frac{1}{30}$ of an inch, which is sufficient to exclude the spectra of the coarser as well as the finer lines (Fig. 7). The examination shows that, even as far as lines 1780 to the inch go, all resolving power has departed, the two gratings being replaced by a plain silver band without any trace of lines.

In all these experiments in which a slit has been employed, it will have been observed that the sides of the slit are parallel to the direction of the lines; but it will be found that if the diaphragm is turned so that the slit is at right angles to the lines, all the spectra will be readmitted and perfect definition result, proving that it is the position of the stops relatively to the striæ, and not their form alone, which produces the phenomena.

The ordinary adapter used for rotating the analyzing prism of a binocular microscope is a convenient instrument for adjusting the stops, which may be placed at the end of a small tube of a size suitable for entering the objective when necessary. The same effects of duplication or obliteration of lines may be produced on such an object as *Lepisma saccharina* by using higher powers with suitable diaphragms.

The limit of visibility is a direct consequence of the demonstration that no resolution can be effected unless at least two pencils are admitted; and as the admission of a secondary or spectral image is absolutely dependent on the aperture of the objective, it follows that the resolving power is a function of such aperture, of which we know the superior limit to be 180°; when the limit of resolving power with oblique light has been reached, the illuminating ray will be seen at the extreme edge of the back lens with the spectral image on the opposite margin, as in Fig. 11.

The rule given by Professor Abbe for determining the greatest number of lines per inch which can be resolved by oblique light will be found (taking any given colour as a basis) to be equal to *twice the number of undulations in an inch multiplied by the sine of half the angle of aperture.*

As the sine of an angle can never exceed unity, the maximum will be equal to twice the number of undulations in an inch in that ray of the greatest refrangibility which will afford sufficient light for the purpose. With *central* light, the maximum for any assigned colour will be equal to the number of undulations in an inch.

What that colour should be is incapable of determination generally, as the capacity for appreciating light varies with different individuals.

If, for instance, we take 43μ in the spectrum as being sufficiently luminous for vision, we find the maximum, as far as *seeing* is concerned, to be 118,000 to the inch; but as the non-luminous chemical rays remain in the field after the departure of the visible spectrum, a photographic image of lines much closer together than those named might be produced.

How little is gained in "resolving" power by such an excessive aperture is at once seen when it is considered how slowly the sines of the larger angles increase, a reduction of the angle from $180°$ to $128\frac{1}{3}°$ causing a reduction of 10 per cent. only in the resolving power, with an immense increase in the general utility of the glass; or, if reduced to $106\frac{1}{4}°$, we still have a resolving power equal, on the same hypothesis, to 94,400 lines to the inch.

The next experiments are made with crossed gratings, and give equally important results.

These gratings are prepared by ruling two sets of lines through silver films as before, one set being ruled on the under side of a thin glass cover and the other on the slide; the two pieces of glass with the lines in contact at an angle of $60°$ are cemented together with Canada balsam, and of course give rhomboid markings over the entire structure (Fig. 13).

4th Experiment.—The object of the first experiment with crossed gratings is to show that with a certain arrangement of the incident light both sets of real lines disappear, and are replaced by one set of perfectly distinct spurious lines parallel to a diagonal of the rhombic figure (Fig. 14). This is effected by using a single slit stop, with the slit in the direction of one of the diagonals, when the spurious lines will appear parallel to the other diagonal, and therefore at right angles to the slit.

If a crossed slit, as in Fig. 15, is used, two sets of spurious lines will appear at right angles to each other (Fig. 16), although the real lines, from which they originate, are at an angle of $60°$. The reason of this will be at once understood, from the previous experiments, to arise from the admission of two sets of spectra, the directions of which are parallel to the diagonals.

An experiment identical in principle is shown on a rectangular grating, Fig. 17, in which with a slit admitting one spectrum, such as is seen in Fig. 19, both sets of lines (vertical and horizontal) disappear, and are replaced by one set (Fig. 20) intersecting the squares formed by the real lines, and therefore closer in the proportion $1 : \sqrt{2}$.

5th Experiment.—The object of this experiment, which is perhaps the most important of all, is to show that with only one row

of spectra, the structure of such an object as that under consideration is absolutely indeterminate.

In this experiment the slit diaphragms are entirely discarded, and the crossed grating is examined with a simple circular stop, which is used merely for the purpose of so reducing the angle of aperture that the first row of spectra only shall be admitted.

The illumination is central, and an examination of the interior of the tube shows seven pencils of light, the bright dioptric beam being in the centre of the field, with six equidistant spectral rays around the margin.

Let it now be clearly borne in mind that we are about to examine a structure which we *know to be entirely composed of distinct rhombic markings.*

On replacing the eye-piece for this purpose, we see *hexagonal* markings over the entire field, as in *Pleurosigma angulatum*, and this effect has been produced by simply so reducing the aperture relatively to the fineness of the object, that the first spectra only are admitted.

From this microscopic image we can infer nothing as to the real structure of the object under examination; we know it to be rhombic, but it appears to be hexagonal.

But the bright central beam and six coloured spectra which have produced this result, are identical in aspect with that presented by a single valve of *P. angulatum* with central light. Compare Fig. 12 and the inner ring of Fig. 14.

This diatom with central light, under the highest powers and with the largest apertures, necessarily presents the same spectral appearance, in consequence of the fineness of the striæ, or holes (whichever they may be), the dispersion being too great to admit the second row of spectra.

It has now been proved that, with the means employed, no definite inference could be drawn of the real structure of the artificial object, and it is equally certain that this demonstration will apply with equal force to the valve of *P. angulatum*, the hexagonal markings of which may, to use the words of Professor Abbe, arise from "two sets of lines, or three sets of lines or isolated apertures of *any* shape in the object itself."

If it were possible to admit the second row of spectra, a nearer approach to a knowledge of the true structure would be obtained, as the larger the number of diffracted rays admitted, the greater the similarity between the image and the object, the keystone of the theory being that "*the interference of* ALL *the diffracted pencils, which come from the object, produces a copy of the real structure*," as in a dioptrical image; but this, as has been abundantly shown, is rendered impossible by the great dispersive power of many fine structures.

Further illustrations of the formation of hexagonal markings may be found on the same diatom.

On bringing into focus a good specimen of *P. angulatum* flat and with distinct-looking lines, using a broad beam of central light, the six diffraction spectra before alluded to may be distinctly seen within the margin of the back lens of the objective (Fig. 12). Any two adjacent spectra combined with the central cone of light will form an equilateral triangle, and produce the well-known hexagonal markings; but as any other pencils forming an equilateral triangle will also produce hexagonal markings, a *new set* on a dark field may be formed by excluding the central and each alternate diffraction ray: the sides of this triangle being longer than in the common figure, in the proportion of $\sqrt{3} : 1$, the new hexagons will be *three times* as numerous as those usually seen, and with their sides at a different angle to the median line. The three pencils producing the interference in this case are *g, c, e,* or *b, d, f,* and the hexagons will have their sides normal to the axis of the scale, not parallel as in the common image. Not only is this so, but it follows from the theory that there must be visible three other sets of lines, bisecting the angles between the common lines, and corresponding to the combinations of the spectra, *g, c,* or *f, d*—*b, f,* or *c, e*—*b, d,* or *g, e.* All these phenomena may be observed by stopping off the pencils which are to be excluded. It is easy to get the lines bisecting the angles of the common rows, one after the other, and of these one set parallel to the axis of the scale. For that purpose oblique light must be used, and the central beam and one of the peripheral rays must be stopped out, leaving for instance *b* and *f*, or *c* and *e* (i. e. two spectra parallel to the median line).

In conclusion, I can only express my sincere regret that Professor Abbe's recent visit to London took place during our recess. Had it been otherwise, the Society would have been gratified by an account of his most important investigations and experiments from his own lips, very much more perfectly than I can possibly have done. But my object has been accomplished if, in bringing before the Society this wonderful contribution to microscopic science, I have induced the Fellows to appreciate the important considerations to which it necessarily gives rise.

NEW BOOKS, WITH SHORT NOTICES.

How to Choose a Microscope. By a Demonstrator. With eighty illustrations. London: Hardwicke and Bogue, 1877.—The author of the pamphlet now before us is highly to be admired for his modesty in concealing his name from the public, the more so as he has really done good work. We have read all the advice he has given, and we are perfectly satisfied with it. It is plain and matter-of-fact in its dealing with the instrument, and, moreover—a circumstance of great importance—no one man's manufacture is paraded before the reader; in fact, no allusion is throughout made to any maker's name. But what is of importance is the fact that we have the opinion of one who is evidently practically experienced with the instrument he is describing on subjects which are of immense significance in the selection of a microscope, and which are nevertheless almost entirely unknown to the junior student who has to purchase a microscope. Advice is given in regard to the instrument itself, to its eye-pieces and objectives, and then to the various additional apparatus, such, for example, as the condenser, various illuminators, spectroscope, polariscope, micrometer, compressorium, dissecting knives, &c. Finally, some sensible remarks are contained in the last chapter, entitled, "What ought I to give for a Microscope?" All this matter is nearly faultless. And especially would we commend the writer's opinions on the subject of binocular microscopes. We know that on this point numbers will be against him, but we still think there is considerable truth in his objections to these instruments.

And now we have a word to say in a depreciating tone. In the first place, the illustrations are abominable; in the second, they are most objectionably situated, half of the eighty being placed on a plate as the frontispiece, and half similarly situate on an end page of the pamphlet. Then, again, the system of employing different forms of type throughout the pages, is a habit for which we must take the author alone to task, and we must say we think it painful to anyone who possesses a sensitive vision. In conclusion, we can honestly recommend the pamphlet to intending workers at the microscope.

PROGRESS OF MICROSCOPICAL SCIENCE.

"*On certain Amœbæ.*"—This is a paper by Professor Leidy, read in October last before the Philadelphia Academy. He said that one of the species of Amœba which he had most commonly seen, he took to be the *Amœba verrucosa* of Ehrenberg, with which the *A. natans* of Perty, and the *A. terricola* of Greef, appeared to him to be synonymous. This species he had found in many places: in the crevices of the brick pavement in the yard attached to his residence, in brick ponds,

in the ooze of the rocky shores of the Schuylkill River, in sphagnum swamps, in marsh mud, &c. It is remarkable for its sluggish character; and in appearance reminds one of a little pile of epithelial scales, or fragment of dandruff from the head. Appearing quadrately oval or rounded, transparent, and more or less wrinkled, or marked with delicate wavy lines; the pseudopods rise in short obtuse mammillary eminences or wave-like ridges, the summits of which are composed of transparent ectosarc, while the central portion of the body is occupied by a thin, pale, diffused, and finely granular entosarc. This contains one or more vesicles, usually one, which very slowly enlarges, and then less slowly collapses. In addition, as part of the structure, an oval granular nucleus is sometimes visible. The food contents generally appear not to be abundant, and often the creature appears to be empty of food altogether. The character of its food is the same as with other species of Amœba. It not unfrequently feeds on Difflugians. In a specimen from sphagnum water, from Vineland, N.J., last August, he observed an individual, about the $\frac{1}{10}$ of a millimeter, containing a Difflugia and a Trinema together. As observed by him, the species ranges from $\frac{1}{25}$ to $\frac{1}{6}$ of a millimeter in diameter. On the morning of August 27, from some mud adhering to the roots of *Sparganium*, obtained the day previously in a nearly dried-up marsh, at Bristol, Pa., he obtained a drop of material for examination with the microscope. After a few moments he observed an *Amœba verrucosa*, nearly motionless, empty of food, with a large central contractile vesicle, and measuring $\frac{1}{25}$ of a millimeter in diameter. Within a short distance of it, and moving directly towards it, was another and more active Amœba, the species of which he was not positive. It was, perhaps, the one described by Dujardin as *A. limax*, by which name, for the present purpose, it may be called. As first noticed, this Amœba was limaciform, $\frac{1}{8}$ of a millimeter long, with a number of conical pseudopods projecting from the front broader end, which was $\frac{1}{16}$ of a millimeter wide. The creature contained a number of spherical food vacuoles with sienna-coloured contents, a large diatom filled with endochrome, besides several clear vacuoles, a posterior contractile vesicle, and the usual granular entosarc. The *A. limax* approached and came into contact with the motionless *A. verrucosa*. Moving to the right, it left a long finger-like pseudopod curved around its lower half, and then extended a similar one around the upper half until it met the first pseudopod. After a few moments the ends of the two pseudopods actually became connate (the second time he had observed this phenomenon), and the *A. verrucosa* was enclosed in the embrace of the *A. limax*. The latter assumed a perfectly circular outline, and after awhile a uniformly smooth surface; but the central contractile vesicle remained in the same condition, nor did he once observe it enlarge or collapse. The *A. limax* now moved away with its new capture, and after a short time what had been the head end contracted, became wrinkled and villous in appearance, while from what had been the tail end a number (ten) of conical pseudopods projected. The *A. verrucosa* assumed an oval form, and the contractile vesicle became indistinct, without collapsing. Moving on, the *A. limax* became more slug-like in

shape, measuring about $\frac{1}{7}$ mm. long, by $\frac{1}{28}$ mm. broad. The *A. verrucosa* now appeared enclosed in a large oval clear vacuole, was constricted so as to be gourd-shaped, and had lost all traces of its contractile vesicle. Subsequently, the *A. verrucosa* was doubled upon itself; and at this period, the *A. limax* discharged from one side of the tail end, the siliceous case of the diatom, which now contained only a shrivelled cord of endochrome. Later the *A. verrucosa* was broken up into five spherical granular balls, and these gradually became obscured and apparently diffused among the granular contents of the entosarc of the *A. limax*. At one moment the five granular balls derived from the *A. verrucosa* appeared to be contained in three vacuoles, and the *A. limax* had a more contracted and radiate form, and then measured $\frac{1}{125}$ mm. in diameter. The observation, from the time of the seizure of the *A. verrucosa* to its digestion, or disappearance among the granular matter of the entosarc of the *A. limax*, occupied seven hours. From naked Amœbæ, the test-protected rhizopods were no doubt evolved, and it is a curious sight to observe them swallowed, home and all, to be digested out of their home, just as the contents of diatoms are digested. It was also interesting to observe the cannibal Amœba swallowing another, and appropriating its structure to its own, just as we might do a piece of flesh, completely, without there being any excrementitious matter to be voided.

Microscopic Organisms in the Blood of Patients suffering from Typhus.—The 'Academy' * states that in connection with Obermeier's remarkable discovery that the blood in relapsing fever is infested by a species of *Spirochæte*, it is worthy of note that the same organism has lately been found in considerable numbers by Manassein † in the liquid exuding from a fistulous passage communicating with the antrum of Highmore; pus-cells and crystals of cholesterin were also present. The patient was in good health; examination of the saliva and the blood yielded negative results.

Microscopic Investigation of the Campagna Marsh Poison.—A series of researches that have recently been made upon this subject is of intense interest, although we cannot be certain as to the correctness of the results. The experiments have been conducted by Signori Lanzi and Terrigi.‡ "In the endochrome of algæ growing in the Campagna and Pontine Marshes, the former observer has discovered certain minute dark granules, which increase in number as the algæ die and pass into decomposition. They belong to Cohn's group of pigmented sphærobacteria (*Bacterium brunneum* of Schröter), and yield *Monilia penicillata* of Fries on cultivation. The so-called 'pigment granules' present in the liver, spleen, and blood of persons who have suffered from malarial diseases are identical with the above germs. By cultivating such granules from a human liver, Lanzi succeeded in obtaining a *Zooglœa*. On the basis of these observations, the writers construct a theory to account for the pre-

* December 9, 1876.

† 'Centralblatt für die Med. Wiss.' October 21, 1876.

‡ Vide Abstract in 'Centralblatt,' No. 40, 1876.

valence of malaria at certain seasons. The marshy pools formed in the Campagna during the winter months are found to swarm with algæ, both green and colourless, in early spring. As summer approaches, the level of the water in these pools sinks, owing to evaporation, and great sheets of dead and decaying algæ are exposed to the air. In these, the sphærobacteria grow and multiply; they may be found in vast numbers in the air to a height of fifty centimeters above the surface of the marsh. Swept hither and thither by the wind, they excite malarial disease whenever they happen to penetrate into the human body."

How Nerves end in Tendon.—The terminations of nerves in muscle has been carefully studied by Dr. Beale, F.R.S., and also by certain French and German observers. Their terminations in tendon is a subject of more novelty. It seems, according to a notice in the 'Academy' (December 9), that the tendon of the sternoradialis muscle in the frog receives a nerve-trunk of some size near its point of insertion; the fibres form a network, and end in the tendon. By employing special methods of examination, Rollett * has succeeded in demonstrating that the ultimate fibres terminate in structures which he terms "nerve-flakes," and which present many points of similarity to the motor end-plates in striated muscle. Their functional significance is doubtful. No reflex movement can be produced by stimulating the tendon; hence Rollett concludes that the nerve must consist of centrifugal fibres.

The Structure of the Optic Bâton in Crustacea.—This part, which may generally be described as that portion of the eye — whether simple or compound — which extends from the cornea in front to the optic nerve behind, and which to some extent corresponds to our aqueous humour, has been fully described in a paper which has just been read before the French Academy of Sciences by M. J. Chatin.† The author states that extending in the directions already indicated its appearance is filiform, and it may readily be divided into two distinct parts; the one external and hyaline—the *cone*, the other internal and notably elongated, and to this is given the special name of *bâton*. Sometimes this latter is of the same diameter throughout; at others it is wider at its terminal part, and often is subdivided into a series of prolongations over the surface of the *cone*. A pigmentary matrix surrounds the *bâton*, and communicates a deep tint to it, a tint which it is necessary not to confound, as is sometimes done, with the proper colour of the *bâton*. This in many crustacea shows a series of transverse striæ and intermediate spaces which have led to the belief that it had a distinct muscular tunic. This idea the author thinks originated with the German school, which has generalized too much, and hence has established as facts what are mere suppositions. Besides, the work carried on by Germans, to which he refers, has been chiefly on insects alone, and he believes that he can mention certain facts which render a belief in the muscular filaments impossible. If

* 'Centralblatt,' October 21, 1876.
† 'Comptes Rendus,' No. 22, t. 83.

we study in the fresh condition the *bâtons* of various species—of the crayfish, for instance—and placing them in a drop of the liquid serum of the body, we very soon find that the brownish colour which is usually attributed to them belongs to the pigmentary cells with which they had been surrounded; their colour is absolutely of a very elegant roseate hue. And this observation is completed by the following: on the surface of each *bâton* may be seen lines which appear to divide it into equal segments, and, prepared in the manner described above, it may be seen that it separates into discoidal lamellæ. The author records the same facts as having been observed by M. Schultze in his researches on Batrachians and Fish, but there must be no homology between the eyes of fish and crustacea. Neither can we [Ed. 'M. M. J.'] conclude with M. Chatin that there is no trace of muscular tissue in either the eyes of crustacea or fishes, though of course we admit the former part of the statement.

The *cone*, which corresponds to the *crystalline lens* of various writers, seems to be of a variable appearance (ovoid, prismatic, or club-shaped), and presents a characteristically refractive power. At its upper part may be seen the cells of Semper, the importance of which Claparède has shown. In some cases one may see towards the central region a line which has been styled the "filament of Ritter." He thinks that the axile line of the cone should be generally regarded as indicating the plane of intersection of pieces originally distinct. The author thus classifies the Crustacea in accordance with the development of the eye: *Astacus*, *Homarus*, *Squilla*, *Eupagurus*, *Pagurus*, *Paguristes*, &c., possess *bâtons* of a decidedly superior form, and also may be added *Cypridina*. But in *Typton Lysianassa* and *Isœa* one observes a manifest simplicity in the *bâtons*, which is still more evident in *Notopterophorus* and *Caprella*. It shows itself more completely still in *Epimeria*, and, above all, in *Lichomolgus*, where the eye is reduced to a small number of elements that show hardly any relation to the foregoing.

A Contest as to Priority of Discovery.—Those who read the 'American Naturalist' will have observed in a recent paper that Mr. A. S. Packard, jun., makes a claim which appears to us so just that we have no hesitation in calling attention to it. In a review of Dr. Paul Mayer's recent essay on the "Ontogeny and Phylogeny of Insects," Mr. Packard very ably attacks the German writer. He says:

"'Ontogeny' is a term devised by Haeckel, and means the development or embryonic and post-embryonic changes of the individual; 'phylogeny' corresponds to its English equivalent, 'ancestry,' while the present essay is an attempt to explain the origin and ancestry of the six-footed insects (Hexapoda) from embryological and anatomical data. No new facts, as far as we are aware, are presented by the author, whose essay has, apparently, contrary to usage in German universities, been crowned not for the original work it contains, but for the ideas suggested by the labours of preceding authors.

"In trying to reconstruct the form of the primitive insect, Mayer

insists that it should be done from a study of the winged adult or *imago*, 'since *a priori* we cannot know how far the form of the larva is original or secondary.' Other authors have with better reasons derived the ancestral form from the larva.

" Mayer's ancestral insect, then, which he calls *Protentomon*, had a body divided into a head, thorax, and abdomen, the latter consisting of eleven segments, while there were six thoracic feet with five-jointed tarsi, and two pairs of wings, nine (and perhaps eleven) pairs of stigmata, a pair of salivary glands, and four excretory organs or Malpighian vessels, besides a well-developed nervous system, heart, and an aorta, as usual in existing insects.

" This hypothetical *Protentomon* is derived by Mayer from the worms,* in opposition to the suggestions of Fritz Müller and Brauer that the insects originated from the Crustacea. This worm, the parent of the half a million species of insects which have peopled the globe during the present and past ages, was 'an unjointed worm, a common starting-point for the Tracheata and higher worms, and also a near relation of the ancestral form of the Crustacea.' This worm then (1) transformed into a higher organism, with eighteen joints to its body and at least fourteen pairs of segmental organs, with perhaps also a masticatory apparatus in the form of jaws; and was perhaps nearly related to the existing Annelids. (2) A third step towards the insects was a form similar to the second, but with ventral and perhaps also dorsal appendages on all the segments; it was still aquatic. It transformed (3) into a worm with tracheæ and with dissimilar segments (the appendages in part beginning to disappear). It lived in fresh water, and is called by our author *Prototracheas*. (4) This *Prototracheas* became an *Archentomon*, still aquatic, with six feet, and clearly defined head, thorax, and abdomen. Finally, this fifth form acquired two pairs of wings, was terrestrial in its habits, and became (5) a *Protentomon*.

" The author then discusses the ancestry of the different orders of insects. It is noticeable that in treating of them he begins with the Hymenoptera and ends with the Neuroptera, following in fact, unconsciously, the reviewer's classification proposed in 1863. The Linnæan Neuroptera are, however, broken up into several orders, the author following the usual German system; but Mayer is the first German author, so far as we are aware, who places the Hymenoptera at the head of the insects, and the Coleoptera in the neighbourhood of the Hemiptera and Orthoptera, where they unquestionably belong.

" Mayer adopts the suggestions of Bütschli and Semper that the air-tubes of insects originated from the segmental organs of worms, and, discarding Gegenbaur's view that the air-tubes were at first internal, closed air-sacs, he believes that the stigmata or breathing holes were the first to be formed. It may be objected that as insects are already provided with renal vessels, it is not necessary to suppose

* This view was advocated by Mr. Packard (though Mayer does not mention it) in 'Our Common Insects,' chap. xiii., entitled "Ancestry of Insects" (1873). This is the more inexcusable since Dr. Mayer quotes from the essay.

that segmental organs (also in part excretory) survived in them, and the inquiry arises whether the air-tubes of insects may not have arisen from the water-vascular system of the lower worms, which communicates with two or more external openings. In framing hypotheses like these, one guess may be as good as another.

" The author, in a footnote, combats with considerable unction our suggestion, made in 1867, that the head of insects consisted of seven segments. It may be observed that at that time we were influenced by the prevailing views of Agassiz, Dana, and others, who regarded the ocelli and eyes as homologues of the limbs. This view was corrected in the 'Memoirs of the Peabody Academy of Science,' ii. 21, 1871 (a work from which our author quotes), and also in several other places, including the 'Guide to the Study of Insects,' third edition, 1872; and the view that the normal number of cephalic segments is four was at the same time and in the same places insisted upon.

" Dr. Mayer also quotes us as believing that the parts of the ovipositor are not homologous with the legs, a view we suggested in 1866, but after fresh embryological studies retracted in the above-mentioned Memoir in 1871 (which the author seems to have read), and also in other places, notably the essay on the "Ancestry of Insects," quoted by Mayer, where the view that the ovipositor of the Hymenoptera, Hemiptera (Cicada), and Orthoptera, as well as the spring of the Thysanura and the spinnerets of spiders, are homologues of the legs is emphasized.

" As regards the position of the primitive band of insects, Mayer ignores the remarks of Dr. Dohrn on its significance in classification, and considers that the circumstance whether the primitive band is external or floats within the yolk is of much importance, laying down the law that 'insects with an external primitive streak are in general older than those with an inner.' We have previously * objected to Dohrn's classification of insects into 'ectoblasts' and 'entoblasts,' and would make a similar objection to Mayer's views, since in weevils (*Attelabus*), abundantly proved by Dr. Le Conte to be the oldest of Coleoptera (a fact ignored by Dr. Mayer, whose genealogical tree of Coleoptera represents the antiquated classification of this order), we demonstrated that the primitive band is external, while in *Telephorus* it is internal, though our observations are called in question by Dr. Mayer, who, however, so far as we know, has never published any observations on the embryology of this or any other animal, the entire essay being based on facts observed by previous writers.

" While the essay is interesting and suggestive, the leading idea, that hexapodous insects first appeared as winged organisms and not as larval forms, will, we think, be found to have no valid foundation. We should with as much reason derive the acalephs from an ancestral free-swimming medusa, and not from a hydra-like form, or the Amphibia from the tailless rather than the tailed forms, views with which we imagine few zoologists would agree."

* "Embryological Studies on Hexapodous Insects," 'Memoirs of the Peabody Academy of Science,' 1872, p. 15.

Bacteria of Denmark.—A Danish naturalist, Dr. Eug. Warming, has been devoting himself to this subject, and has published a paper, which is given in an abstract of some length in the 'Journal of Botany' (December 1876). We can, however, only find space for a portion of this notice. It seems that all along the Danish coast there is found, during calm weather in the summer months, a red coloration of the water close to the shore. The cause of this singular phenomenon is referred to Bacterioid masses which cling to Zostera and seaweeds, and, as might be expected, lose their hold when a storm or a high tide supervenes, and do not regain their position and appear in sufficient quantity to colour the water until calm has been restored. The wet weather of autumn also breaks up the masses, but during the whole winter it is possible to find plants covered with Bacteria capable of ready revival, even if their habitat be frozen over. Professor Warming has made a study of this subject with his usual care and success, the results of which—the discovery of several new specific and varietal forms, and the broaching of theories as to structure, reproduction, and classification—are noticed in a brief manner. Sometimes floating masses composed of *Clathrocystis roseo-persicina* occur, but most Bacterioid life is found below the surface; here, when decomposition has only slightly advanced, one sees principally small individuals of *Monas vinosa*, but at further stages many other red-coloured forms as well as various colourless ones are developed. A common species is *Monas Okenii*, of which the Danish examples are not so deeply coloured as are those figured by Cohn; marine specimens are oval or cylindric and straight, fresh-water ones somewhat spiral in form; smaller individuals have a single posterior cilium, the larger one at each end. As to division, Professor Warming believes that only the small ones exhibit it; occasionally very long cells were found, but they were not constricted in the middle, and showed no sign of division. This does not appear to exhibit a "zooglea" state. Then follow various other species, till we come to *Bacterium sulphuratum*, under which name are united a number of forms, which together make up the chief part of the red coloration. The states in which this appears are:—1. As spheres (*Monas vinosa*, Ehrbg). 2. As roundish bodies, usually with a constriction and with granules grouped at the ends (*Monas Warmingii*, Cohn). 3. Like *Monas vinosa*, but crowded with sulphur-grains (*Monas erubescens*, Ehrbg.). 4. Long, narrow, cylindrical, and filled with sulphur-grains (*Rhabdomonas rosea*, Cohn). Finally, the series is brought to a close by a spiral form, the amount of torsion varying from scarcely anything to more than one complete turn. Professor Warming is at a loss to know what becomes of the large forms; he thinks it possible that they form a sort of spore like Ascococcus. He then describes various other species, which are pretty fully given by the 'Journal of Botany,' which concludes as follows:—Professor Warming did not succeed in directly making out the cell-membrane; in the true Bacteria he has never seen the plasma shrink from the cell-membrane by the action of reagents, neither has he observed any internal molecular or granular movement. Sometimes, however, vacuoles are formed round the

periphery, and then the membrane is shown very distinctly. The grains of the plasma are of two kinds:—1. Strongly refringent, without a well-defined bounding circle; these are merely compacted masses of the plasma. 2. The ordinary sulphur-grains resemble oil-drops, and are surrounded by a dark circle. The only form of multiplication observed was by division. Moreover, the "zooglea" state was never seen in salt-water infusions.

Ganglion-cells in the Heart of the Crawfish.—A paper has been read on this subject recently before the Royal Academy of Sciences at Vienna, by Herr Emil Berger. However, as merely the title is given in the weekly reports of the 'Academy,' we merely announce the fact of its publication.

The Sexual Organs of Squilla mantis.—This subject, similarly to the preceding one, has had a communication on it read before the Royal Academy of Sciences at Vienna, but merely the title is given in the 'Proceedings.' The author of the memoir was Herr Carl Grobben.

Dr. Braithwaite's Book on British Sphagnaceæ.—Dr. Braithwaite announces the intended issue to subscribers of 'Sphagnaceæ Britannicæ exsiccatæ,' which will include about fifty forms, illustrating his recent monograph, in the choicest dried specimens, both mounted and loose for microscopic examination. Three Continental species not found in Britain will also be included. Only fifty copies will be prepared, in imperial quarto size, price 25*s.*, and the author will be glad to have the names of those desiring to possess the work. Address, The Ferns, Clapham Rise, London.

Eriksson on the Dicotyledonous Root.—The December number of the 'Journal of Botany,' quoting from the 'Botanische Zeitung,' says that Herr Eriksson's views on the above subject differ from those of Herr Holle, which the 'Journal of Botany' gives at some length. It says that he admits four types of structure:—1. The root-end has three separate Meristem-tissues, of which the Plerom gives origin to pericambium, fibro-vascular bundles, and pith; the Periblem acts as the Meristem of the primary bark-layers, and the Dermatogen or Dermatokalyptrogen produces the epidermis and root-tip (Haube). The Periblem of this type arises either from a single cell-row (Initialenreihe), or from two or from three or more cell-rows. 2. Two Meristem-tissues are present in the root-end; a Plerom and a single tissue for the production of primary bark-layers, epidermis, and root-tip. 3. Only a single Meristem-tissue is found. 4. This shows Plerom and Periblem, but the latter is external, and builds up the root-tip from without inwards. Numerous instances of the occurrence of each type are given, and a fuller treatment is promised at some future time.

The Ambiguous Position of the Monads.—We have additional discoveries regarding the nature of monads by the Russian naturalist, Cienkowski. These organisms are on the border-land of the plant world, and in some cases form protoplasmic nets (plasmodia) like the

plant *Myxomycetes*. These plasmodia have the function of falling apart into amœba-like forms, which have hitherto been regarded as independent animal organisms; hence he thinks that many Amœbæ do not represent independent forms, but belong to the developmental cycle of other and plant-like organisms. Among the monads, Cienkowski, according to a German correspondent of 'Nature,' has observed forms in various stages of encystment, self-division, and formation of colonies. But the most remarkable series of changes were observed in *Diplophrys stercorea*, an extremely small cell-like organism with a yellow spot and pseudopodia at two opposite ends of the body. These little bodies, observed in moist horse-dung, multiply by division, and form by union of the pseudopodia long strings in which separate individuals can glide to and fro. "Thus the boundary lines which it has so long been usual to draw between plant and animal organisms, and between the individual groups of those lowest forms of life, appear more and more illusory, and the supposition is recommended of a common lowest kingdom of organisms, that of Protista (Haeckel), out of which animals and plants have by degrees been differentiated."

The Life-history of the Salpæ.—Mr. W. K. Brooks has published a very interesting paper on the subject of the development of the Salpæ. In this he traces out their entire life-history, and by the aid of several cuts which he has borrowed from Professor Agassiz fully illustrates this subject. The paper is in the 'American Naturalist' for November; and although it contains nothing new, still the following paragraph is worthy of quotation:—"The life-history of Salpa may then be briefly stated in outline as follows: The solitary Salpa is the female, and produces a chain of males by budding, and discharges a single egg into the body of each of these before birth. These eggs are impregnated while the chain-salpæ are very small and sexually immature, and develop into females which give rise to males by budding. After the fœtus has been discharged from the body of the male, the latter attains its full size, becomes sexually mature, and discharges its spermatic fluid into the water to gain access to the eggs carried by other immature chains."

Microscopical Contents of Foreign Journals.

Archives de Physiologie, publies par Brown-Sequard, &c. No. 2, Mars, Avril, 1876.—The first paper is partly a microscopical one, and is of great physiological importance. It is on "The Condition of the Persistence of Sensibility in the Peripheric Ends of Divided Nerves." It is illustrated by a series of five coloured plates. This is the only paper of histological interest.

Journal of Anatomy and Physiology, vol. xi. part 1. Edited by Messrs. Humphrey, Turner, &c.—This contains several papers of interest to the microscopist. Among the more important are the following: "On the Development of the Mamma," by C. Creighton, with a plate; "On the Stomach of the Fresh-water Crayfish," by T. J. Parker, with a plate; the second part of the paper "On the

Anatomy of the Arms of the Crinoids," by P. H. Carpenter; "On the Structure of the Retina," by Dr. J. C. Ewart and Dr. G. Thin. This is a most valuable paper, and we regret that it has had to be reduced in length to meet certain editorial requirements, for it was before its reduction a useful summary—besides the author's own investigations—of the progress that has up to Max Schultze's time been made in this direction of microscopic work.

Archives de Zoologie Expérimentale et Generale, publiées sous la direction de H. de Lacaze-Duthiers. Tome 5. 1876. No. 1.—This number is much taken up with a zoological paper which has no microscopical interest. Still it has one important communication on the development of Mollusks, by Dr. Hermann Fol. This paper, which is one of a series, is upon the embryonic and larval development of the Heteropoda, and is admirably illustrated by four well-executed and some of them coloured plates. Some of the terms used seem to be peculiar in their application. Thus the word *lecith*, and its compounds proto-lecith and deuto-lecith. Of this the author says: "With me the term lecith is synonymous with vitellus; the proto-lecith is the nutritive substance which the ovule possesses as it leaves the genital gland; the deuto-lecith is the nutritive material that the vitellus absorbs only after fecundation and even after division of the yelk" (*après le fractionnement*). This is a long paper (over 30 pp.), and it follows out the development of certain genera of Heteropods with much minutiæ.—Another paper of considerable value is a review of Herr R. Hertwig's paper, "A Contribution to the History of Acineta-forms." The author describes at some length a fine species, *Podophrya gemmipera*, which is found in Heligoland on the stems and branches of almost all the hydroid polyps of the shore. The paper has an especial importance, from the fact that it combats with Cienkowski the idea that all the species have a special wall or envelope enclosing them. He shows that some of them remain naked through their entire life.

NOTES AND MEMORANDA.

An Objective of Mr. Spencer's.—Mr. Spencer is an American maker whose glasses from various circumstances are not likely to come into the English market. We may therefore quote the following passage descriptive of one of his objectives which the editor of the 'Cincinnati Medical News' (December 1876) has had in his possession: —"For several weeks we have had in our possession an immersion $\frac{1}{10}$th, made by Mr. Spencer, marked 160° angle of aperture. In resolving power, brilliancy, and sharpness of definition, flatness of field, and in all the essentials of a pre-eminently *fine* glass, we have certainly never met its superior, and very few its equal. All of the most difficult tests yield to it without the slightest difficulty, and pre-

sent a beauty in their resolution that excites the highest admiration. In comparing its capabilities with a number of the objectives of the most distinguished makers, it certainly had the advantage. Its focal length is quite short, and consequently requires very thin covering glass."

The Fossil Earth of Richmond, U.S.A.—This appears to be an exceedingly rich deposit, and it may be worthy of examination by some of our readers who may have the opportunity of possessing specimens. The 'American Naturalist,' of December last, says of it that the recent excavation of a tunnel by the Chesapeake and Ohio Railroad Company, through that part of the city of Richmond, Va., known as Church Hill, has intersected this famous deposit for a distance of three-fourths of a mile, and afforded rare facilities for study and the collection of material. C. L. Peticolas, of Richmond, who has given great attention to the work of obtaining this interesting material and preparing it for use, describes the stratum as from forty to sixty feet thick, and situated, nearly level, about fifteen to twenty-five feet below the level of the city, and one hundred feet above tide water. Before exposure to the air it is tough and hard, having the colour and solidity of bituminous coal and requiring to be removed from the tunnel by means of blasting; but after exposure for some time it crumbles to a fine powder of almost snowy whiteness, consisting in general of about one-half fine pure clay, one-fourth fine white sand, and one-fourth fossil diatoms interspersed with many sponge spicules and a few Polycystina. The abundance and variety of the fossil forms vary greatly in different parts of the stratum, the lower levels being the richer.

The Blood-stain Controversy.—We have received a copy of the 'American Medical Times' from Dr. Richardson, with a request that we would notice a discussion, that it reports, in the Academy of Natural Sciences of Philadelphia, on the subject of the microscopic detection of human blood-corpuscles. But it seems to us that Dr. Richardson is unquestionably wrong in this matter. We have gone carefully into the subject, with the aid of the magnificent photographs taken from micrometer slides with blood drops on them, which Dr. Woodward sent us, and we have not the slightest hesitation in saying that the blood of man is absolutely indistinguishable, by our present means, from the blood of the dog or guinea-pig.

The 'Science-Gossip' Section Machine bids fair to have a great reputation. The 'American Journal of Microscopy' (January 1877) reprints the paper with the cut which recently appeared on the subject in 'Science-Gossip' itself.

Typical Specimens of the Diatomaceæ.—The 'American Journal of Microscopy' (January 1877) has an important article on this subject, from which we may quote as follows:—"We have just received from Professor Hamilton L. Smith, of Hobart College, Geneva, N.Y., the first century of his 'Diatomacearum Species Typicæ,' and have rarely had a greater treat than was afforded by the examination of this collection. Most microscopists are familiar with the celebrated 'Typen Platte' of Möller, an exquisite production of artistic skill.

The collection before us is an effort in the same direction, but is of a different kind, and in many respects far more efficient and satisfactory. It consists of one hundred slides (the entire collection will probably reach five hundred), each containing typical specimens of a species. With the exception of a few diatoms, such as *Arachnoidiscus Ehrenbergii* and *Aulacodiscus formosus*, there are a large number of frustules on each slide, and in general there are several genera or species present. Thus, on the slide before us, marked *Aulacodiscus Oregonus*, we find several beautiful specimens of a Hyalodiscus. The value of this collection, therefore, does not depend upon the mere manual dexterity exercised (which is the most remarkable feature of the 'Typen Platte'), but upon the authoritative character of the identifications, and in respect to this point, we have no hesitation in saying that Professor Smith stands at the head of living diatomists. Instead of a single frustule of each species, carefully reduced to its mere siliceous elements, we have here a number of frustules; and these, although perfectly clean, are mounted as nearly as possible in the condition which they presented while living, unless this should render them unfit for study. Thus the curious *Bacillaria paradoxa*, instead of being mounted as a mere assemblage of striated rods, is put up in that singular, connected condition from which it obtains its name. From all this it will be seen that these slides are put up to be *studied*, not to be merely *looked at*. They are not intended for those who have never seen a diatom; but, on the other hand, to those who have even the most elementary knowledge of the subject, they cannot fail to prove a reliable and easily followed guide in the determination of species.

"To gather the material for this collection has been the work of many years, and has involved the expenditure of much labour and considerable money. The famous collection of De Brebisson has been transferred entire to Professor Smith's laboratory, and has furnished many rare species, and it might perhaps be safe to say that, in addition to the Professor's own gatherings, there are few diatomists of note that have not furnished him with contributions, either by way of exchange or otherwise.

"The manner in which the collection before us is put up is worthy of notice. Each century, or collection of one hundred slides, is arranged in five pasteboard trays, each slide having a compartment for itself, and the whole being enclosed in a simple but convenient pasteboard box. To the lid of this box is pasted a catalogue of the species, which are arranged in alphabetical order and numbered. Each slide is, of course, labelled, and the label is numbered to correspond with the catalogue. But to prevent any danger of confusion, if the slides should accidentally lose their labels by exposure to moisture or otherwise, each slide has its proper number written in with a diamond. The compartments for receiving the slides are also labelled and numbered, thus affording the most perfect security against misplacement."

A form of Collecting Bottle, which appears to be useful, though we hardly think novel, is thus described by an American journal:— "It consists of a bag or net of some light material, to the bottom of

which is attached, by means of a rubber ring, a wide-mouthed bottle. Any quantity of water may be poured into the bag, and all the objects which it contains will roll down the sides of the bag and fall into the bottle, while the fluid escapes through the sides. Delicate objects are consequently not exposed to pressure, rubbing, or any other violence, as they would be in an ordinary filter or bag, and the whole affair is so simple that anyone can make it."

How to resolve Test-diatoms without any Special Apparatus.— The Rev. J. Bramhall writes as follows to 'Science-Gossip' (January 1877), and as he is an authority on the subject, we think his remarks worthy of quotation:—"Turn the instrument at right angles to the sun; close the diaphragm so as to *cut off all light below the stage;* or, if that cannot be done, place a piece of black paper behind the slide. *Bring the light on to the object at the angle which suits it best.* This is easily done by moving the microscope to the right or left. If necessary, increase the light by the use of the stage or stand bull's-eye condenser. That is all. A black ring round the covering glass is an objection when the cover is small, as it interferes with the light. To carry out this plan successfully, only two things are necessary— viz. the sun, and an object-glass, capable of resolving the test, just before it. It is not intended to supersede the use of the apparatus, for the sun is far too uncertain an illuminator to be depended upon, and most men work by night; but it may be useful to those who cannot afford to purchase any apparatus—not even an oblique illuminator, the cheapest of all. I must justify this allusion to my *pet child* by stating that I have not, and never have had, any pecuniary interest in its sale. Having been asked questions as to its capabilities, I can only repeat what I have before stated, viz. that by its help I can resolve tests which I never could touch before, though possessing achromatic condensers, spot lens, &c."

A new Locality for Amphitetras antediluviana.—Mr. E. D. Marquand states that in the number of 'Science-Gossip' for December 1867,* Mr. F. Kitton contributed a valuable paper on the genus Amphitetras, and amongst others, described this species, together with two varieties of it: β, with sides deeply incurved, and angles much produced; and γ, with five incurved sides. Of the latter (which is figured) Mr. Kitton remarks: "This variety appears to be rare, as I know of only one locality in which it has been found, viz. Hayling Island, Hants, in which it was rare." Mr. Marquand has seen no record of the occurrence of this beautiful diatom elsewhere, and therefore has much pleasure in adding a second locality, also in Hampshire, viz. Lymington. A few weeks ago he collected material from two places, the shore of the Solent below South Baddesley, exactly opposite Yarmouth; and the bank of the river facing Lymington. The first gathering yielded *Amphi. antediluviana*, var. β, in great abundance, but without the typical form; the second produced var. β in less numbers, sparingly intermixed with var. γ.

* Vol. iii. p. 271.

CORRESPONDENCE.

Professors Helmholtz and Abbe on the Optical Powers of the Microscope.

To the Editor of the 'Monthly Microscopical Journal.'

Clifton, *December* 20, 1876.

Sir,—The writings of Professor Abbe, of Jena, on various subjects connected with optical instruments,* are little or scarcely at all known in England. But a translation of his essay on the optical capacity of the microscope appeared, in 1875, in vol. i. N.S. of the 'Proceedings of the Bristol Naturalists' Society'; extracts from which were also published in the 'Monthly Microscopical Journal' of the same year. An essay of Professor Helmholtz, on the optical capacity of the microscope, also appeared in the Bristol Naturalists' Society's 'Proceedings'; and subsequently in the 'Monthly Microscopical Journal,' in 1876.

In the new edition of Nägeli and Schwendener's excellent monograph on the theory of the microscope and its practical application, Professor Abbe's investigations are mentioned in various chapters as introducing a new phase in the solution of many difficult questions connected with the optics of this instrument and with the theory of the limits of the visible. The researches of Professor Abbe are therein estimated as an important contribution, and a decided step in advance.

Amongst many instructive discussions I may refer to a particular result obtained by Professor Abbe, which is dwelt upon with much force in his essay,† namely, that a large class of objects when placed under the microscope and illuminated in the usual way not only transmit ordinary pencils which follow their regular and unaltered course, but also in virtue of some speciality of internal structure diffract other rays, so that a mixture of ordinary and diffracted rays is transmitted to the objective. If then the objective have sufficient aperture to take in some of the diffracted as well as the ordinary rays, two sets of images are produced. The general outlines and larger detail of the object are geometrically delineated by the ordinary rays, while images of the finer details which caused diffraction of the illuminating rays as they passed through the *object*, are reproduced by the reunion of the diffracted rays on the same focal plane as that in which the geometrical image is formed. And consequently the perfection of the complete image would depend in such cases upon large aperture *and* perfect focussing function of the system of lenses. If

* For example. His long article in the 'Jenaische Zeitschrift,' vol. viii. 1874, on "New Apparatus for Determining the Refracting and Dispersing Powers of Solids and Fluids," in which the mathematical principles are discussed on which his refractometer and spectrometer are constructed.

† See 'Archives für Mikroscop. Anatomie,' vol. ix. 1874; 'Beiträge zur Theorie des Mikroscopes;' or Bristol Naturalists' Society's 'Proceedings,' vol. i. N.S. 1875.

the aperture is not sufficient to admit diffracted rays, the objective image is devoid of all details minute enough to cause this diffraction, and which are therefore *ipso facto* thrown out of the picture. On this fact is based a number of deductions of the utmost importance to the theory of the microscope and the limits of visibility, a careful study of which cannot but greatly tend to clear up our ideas of "penetrating" and "resolving" powers, and the true significance of angular aperture.

It is scarcely necessary to remark that the above-mentioned results have no connection with that theory of diffraction occurring *in* the microscope which takes its starting point from the well-known case of the passage of bright pencils of light through pin hole apertures, a case which occurs when an objective of great amplifying power is employed whose optical aperture is necessarily very minute.

Professor Helmholtz's essay deals with the question of light as it passes into, through, and out of the instrument, and the law formularized by La Grange is referred to as a law potentially carrying in itself many yet unknown applications. La Grange himself only proposed to apply a particular deduction from this law as a means of determining the amplification effected by the object-glass of a telescope; whilst Helmholtz employed the formula to demonstrate the relation between brightness of image and amplification in the case of objectives used in the microscope. The optical law of La Grange undoubtedly applies to the focussing function by which an image is geometrically delineated, so that each point in the object is pictured on the focal plane in an exactly corresponding position, that is, in symmetrical disposition round its axis; and Professor Helmholtz has shown that the peculiar photometric relations of the *microscope* image, i. e. the relation between amplification and brightness of image (which, as he expressly states, is not necessarily the same in the telescope), are demonstrable from this law. But it is only when amplification is increased and more light needed that the conditions of diffraction in the microscope are brought into play, so as to present obstacles to further increase of amplifying power. In a letter published in your December number, Dr. Pigott has quoted a passage from my translation in support of a statement which scarcely needs refutation. I will, however, quote another, in which Helmholtz expressly states that "*if, perhaps, occasional allusion has been made to diffraction as a cause of deterioration of the microscopic image, I have nowhere found any methodical investigation into the nature and amount of its influence.*"

It seems hardly worth while to notice Dr. Pigott's allusion to the investigations of the German Professors as a mere attempt to "popularize" a law of La Grange. No one who has made himself acquainted with Professor Abbe's experimental demonstration of the modes in which objectives of wide-angled aperture form images of particles in an object which diffract light when placed under the microscope, will fail to see that the reference to La Grange's law is entirely irrelevant; and in regard to Professor Helmholtz's essay the demonstration of diffraction of light in its passage through the lenses

forms a separate chapter at the end of his essay, in which Helmholtz makes no reference to the formula discussed in the first part. Moreover, the altered expression of this formula is in no sense a "popularization." For to change the terms of a formula, as in the present case, is not to make it less recondite, but to give it a more subtle expression, and a more precise definition. Such formulæ are yet remote from popular thought!

The cases of diffraction caused by interception of light by close-drawn lines (as in ruled test-plates) or minute particles in an object (as in all substances exhibiting minute details of structure) have been specially discussed by Professors Helmholtz and Abbe, and the consideration of such cases led the latter named gentleman to an *experimental verification* of the formulæ worked out by the Professors separately. This experimental verification I have myself, through the kindness of Professor Abbe, witnessed, and I propose to give a short account of the method adopted and its result in the course of a few weeks.

Finally, it may be remarked that Fraunhofer's conjecture "that an object of less linear diameter than a wave-length can never be discerned by microscopes as consisting of parts," which is doubted by Sir J. Herschel, as not being a necessary conclusion from the premises, is fairly met by the mathematical formula which places the limit of visibility at *half* the wave-length, $\epsilon = \frac{1}{2} \lambda_0$, when the divergence angle α_0 is equal to 90° (that is, with employment of immersion objectives). See Helmholtz 'On the Limits of Optical Capacity of the Microscope.'

I am, Sir, yours faithfully,

H. E. Fripp.

Variation in Navicula rhomboides.

To the Editor of the 'Monthly Microscopical Journal.'

Sir,—On reading the excellent paper by the Rev. W. H. Dallinger on the forms and striation of *N. rhomboides* in last month's Journal, one is struck with the evident pains the author has taken to make distinct and generous reference to those writers on his subject who preceded him. It is therefore most certain that only by an oversight—perfectly excusable by reason of the voluminous literature of the diatom—he has omitted to notice the work of Mr. William Hendry, of Hull, who, some fifteen years ago, carefully examined and measured many varieties of *N. rhomboides*, and came to the conclusion that the species "is the most variable in its dimensions, irregular in its form . . . . and possesses a striation more extended in its range than any other known diatom, thus totally unfitting it to take rank, under any circumstances, as a test-object." * In one direction he even went a step beyond later writers, by showing, in his tabulated measurements, that "the numerical striation bears no definite relation to the magni-

* 'Quarterly Journal of Microscopical Science' for 1861, p. 231.

tude of the shell,"—that it is no uncommon thing to find large valves with fine markings, and small valves with coarse markings.

It should be understood that in quoting my friend Mr. Hendry, there is no wish to underrate the very necessary labours of Mr. Dallinger : many observers were in doubt concerning the identity of certain diatoms, and these doubts, I suppose, he has dispelled; moreover, there was much, both in matter and manner, to make his paper a welcome contribution to our Transactions.

In agreeing with Mr. Dallinger that "the microscopist is more generally concerned with the characteristics of the silicious skeleton than with the morphology and development" of the diatom, he will perhaps pardon me for regretting the fact as a misfortune and a mistake. I believe that most of us waste too much time in testing our tools, to the neglect of the useful work which even the worst of them would enable us to do; while there is a certain large class among us who really seem equal to *nothing else* but testing their instruments; their highest ambition is bounded by the desire to exhibit dots and "beads" in competition with their neighbour. These gentlemen only can answer Mr. Kitton's question, "What is microscopical science?" It is buying many objectives, measuring and comparing them, boasting of them, testing, re-testing, and yet again testing them, but never, by any chance, making an original observation with them.

Yours obediently,

HENRY DAVIS.

THE OBLIQUE ILLUMINATOR.

To the Editor of the 'Monthly Microscopical Journal.'

SIR,—The oblique illuminator, which I proposed to name after my friend the Rev. J. Bramhall, was, I know, a new thing, so far as he is concerned. On discovering the effective performance of a reflector parallel to the slide, he at once wrote to me to ask my opinion of its value, and also to ask whether it was new. I made a rough trial, and found, with every disadvantage, it resolved striæ with ease, that had formerly taken me some time to bring out; and as I was not aware that this method of illumination had previously been described, I wrote a short description of it for 'Science-Gossip' and this Journal, calling it the "Bramhall Illuminator."

On June 30, 1876, I received a letter from the Secretary of the Microscopical Department of the Providence Franklin Society (Mr. John Peirce), in which he tells me that "Mr. Norman Mason, of Providence, R.I., accidentally discovered some time ago identically the same thing as you describe as 'Bramhall's Oblique Illuminator.' He was endeavouring to find a piece of plate glass of uniform thickness. He used pieces of broken mirrors, strewed with Lycopodium, for the purpose of focussing, and was astonished at the illumination. He afterwards made use of this illumination for diatoms, and found, as you state, that the distance of the mirror from the object made quite a difference. Yours respectfully, John Peirce."

On July 10, 1876, I received a letter from my friend Professor H. L. Smith, of Hobart College, N.Y., from which I quote the following remarks:—"I have just noticed your account of Mr. Bramhall's oblique light illuminator. It is an old dodge over here. I have one, made over ten years ago; a piece of looking-glass plate with a ledge." It thus appears that this method of illumination has had several discoverers. It seems to have been known in New York five or six years before Mr. Van der Weyde of that city described it in August 1871, as probably a new contrivance; Mr. Mason, of Providence, discovered it "some time ago" (this may mean six or seven years); and lastly, Mr. Bramhall "discovers" the same thing about twelve months ago. But leaving the discoverer out of the question, it is the best and easiest plan for the resolution of striæ I am acquainted with.

Yours very truly,

F. Kitton, Hon. F.R.M.S.

PROCEEDINGS OF SOCIETIES.

Royal Microscopical Society.

King's College, *January* 3, 1877.

Charles Brooke, Esq., F.R.S., Vice-President, in the chair.

The minutes of the preceding meeting were read and confirmed.

A list of donations to the Society since the last meeting was read by the Secretary, and the thanks of the meeting were voted to the donors.

The Chairman gave notice that the next meeting would be made special in order to vote the suspension of Bye-law No. 27 so far as related to the office of President. By the law no person should occupy the office of President for more than two consecutive years, but in accordance with the unanimous recommendation of the Council it was resolved to re-elect H. C. Sorby, Esq., to the office for a third year. To enable this to be done, it would be necessary for the bye-law to be suspended.

The Chairman further reminded the Fellows that the next meeting would be their anniversary, at which the election of officers and Council for the ensuing year would take place; and the following "House List" was submitted, it being competent for any Fellow to propose additional names to be printed with those proposed by the Council:

As *President*—H. C. Sorby, Esq.

As *Vice-Presidents*—Sir John Lubbock, Dr. Lionel S. Beale, Rev. W. H. Dallinger, and Mr. Hugh Powell.

As *Treasurer*—Mr. J. W. Stephenson.

As *Secretaries*—Mr. H. J. Slack and Mr. Charles Stewart.

As *Members of the Council*—Drs. Braithwaite, Lawson, and Millar;

Messrs. Crisp, Ingpen, Jones, Loy, Ward, Brooke, Bevington, McIntire, and Palmer.

The Chairman announced that it was necessary to elect two gentlemen as auditors of the Society's accounts, and requested the Fellows to nominate them accordingly. Mr. B. D. Jackson was then proposed by Mr. Bevington, and seconded by Mr. Thomas Palmer; Mr. Gay was also proposed by Dr. Gray, and seconded by Mr. Curties.

The Chairman having put it to the meeting, declared Mr. Jackson and Mr. Gay to be duly elected auditors.

Dr. Wallich read a paper "On the Development, Reproduction, and Surface Markings of Diatoms," the subject being illustrated by large drawings upon the black-board. (The paper will be found printed at p. 61.)

The thanks of the meeting were unanimously voted to Dr. Wallich for his paper.

Mr. J. W. Stephenson read a paper "On some Experiments Illustrating Professor Abbe's Theory of Microscopic Vision." The experiments were exhibited under the microscope, and illustrated by drawings. (The paper is printed at p. 82.)

The Chairman, in proposing a vote of thanks to Mr. Stephenson for his paper, said that it appeared to him that these experiments clearly showed that diffraction spectra might be produced which presented all the appearances which they were accustomed to see when looking at a diatom; but it did not appear to be a conclusive argument that these appearances might not also be real when produced by diatoms, and certainly it did not appear to be a necessary consequence that therefore the diatom's appearance falsely represented its structure.

Mr. Stephenson said that Professor Abbe would quite agree with the Chairman's remarks; the appearances might be true, or might not; they left the matter quite undetermined.

Dr. Wallich said there was only one point on which he should like to make an observation. He thought the first thing to be decided was what these diffraction images really were. When a diatom was properly illuminated, and when they could show it and show it again just as they ought to see it with different powers, it seemed to him like reality. The first thing he should like to know would be what amount of diffraction was sufficient to define a line?

Mr. Stephenson said that the diffraction images of which Professor Abbe spoke were produced by the structure examined, and appeared in the tube above the back combination of the object-glass.

Dr. Wallich said he was taken some years ago, by their dear friend the late Rev. J. B. Reade, to Dr. Pigott's to see some diffraction images, but they all seemed to him like a confused mass of things, and not at all clearly defined or in any way resembling lines.

Mr. Ingpen mentioned that in the case of Nobert's bands, the diffraction lines were as perfectly clear and sharp as those of the bands themselves.

Dr. Lettsom said that the images shown by Professor Abbe were perfectly clear, and those lines could be seen as distinctly and clearly

as any lines produced by *angulatum*. If Dr. Wallich would favour him with a call, he should be most happy to show him these effects.

Mr. Stephenson said they had only to drop a piece of card with a hole in it sufficiently small to exclude the spectra over the back combination, and they would instantly shut out all the lines; the outline would be seen, but nothing else. If an ordinary Podura scale is viewed through a slit placed in a direction parallel with that of the markings, and afterwards through one placed at right angles to them, totally different effects would be obtained, and when under different conditions so many different effects took place it was rather difficult to say which was correct.

Mr. Stephenson exhibited for Mr. Slack (who was unfortunately unable to be present from indisposition) a slide containing mercury globules mounted in balsam, the balsam having been previously thinned with benzoline and boiled in mounting, there being a probability that the contraction of the globules in cooling had left a vacant space round each. Viewed through a micro-polariscope with prisms crossed, each globule appeared to be semi-transparent (like horn), and to be marked with a more or less defined black cross.

Donations to the Library since December 6, 1876:

	From
Nature. Weekly	*The Editor.*
Athenæum. Weekly	*Ditto.*
Society of Arts Journal	*Ditto.*
Transactions of the Watford Natural History Society. Parts 4 and 5	*Society.*
Journals of the Linnean Society	*Ditto.*
Mémoire sur les Caractères Mineralogiques et Stratigraphiques, &c. Par MM. Ch. De La Vallée Poussin et A. Rénard	*M. A. Rénard.*
Abstract of Proceedings and Transactions of the Bedfordshire Natural History Society, 1875–6	*Society.*

The following gentlemen were elected Fellows of the Society:—Dr. John A. Tulk, M.A.; J. T. Redmayne, Esq., L.C.P.E.; Matthew Hawkins Johnson, Esq.; and James Spencer, Esq.

WALTER W. REEVES,
Assist.-Secretary.

MEDICAL MICROSCOPICAL SOCIETY.

Friday, December 15, 1876.—F. H. Ward, Esq., Vice-President, in the chair.

Rodent Ulcer.—Mr. Golding-Bird read a paper, illustrated by drawings and specimens, upon this subject. Having reminded his hearers of the generally accepted clinical characters ascribed to the disease, he proceeded to analyze the cases published by the principal writers upon the subject from the time (1827) of Dr. Jacob, of Dublin. Referring only briefly to their clinical aspect, he dwelt upon the descriptions given of the histological appearances, but it was much to be regretted that so very few of the large number of cases reported had any thoroughly reliable microscopic analysis.

From this he, however, concluded that the principal English

authorities are agreed now upon the disease being non-cancerous and non-epithelial, but a small-celled growth comparable to the edge of an ulcer rather than to anything else. Some observers make a special arrangement of the cells into columns or circular aggregations, considering this latter essential: with this the author of the paper did not agree; he did not think such a precise arrangement essential, but rather accidental; or if essential to some varieties of the disease, we did not know yet what clinical distinctions corresponded to them. Dr. Warren, of America, Billroth in Germany, and Ranvier in France, all class the disease under cancers, and describe the presence in greater or less degree of epithelial infiltration. Such a view the writer had from microscopic investigation not been able to uphold; and he thought that everything—at least from the clinical aspect—militated against it. Dr. Warren was the only writer, as far as he knew, that had insisted upon a peculiar arrangement of the fibrous tissue. This he had also noticed.

The writer then gave a detailed account of three cases, in one of which there were two returns of the growth after extirpation, and in these he had found an excessive infiltration of small round cells, similar to those of ordinary inflammation rather than to true epithelium; no definite arrangement of the cells; no transition between them and the epidermis, and no projection unduly of the latter down into the cellular tissue; a great abundance of fibrous tissue, formed apparently from the intercellular material; it lay as much under the granulating part of the ulcer as under the skin around; its direction was mostly ascending towards and at right angles to the free surface. It seemed to come from bundles, that threw out bold curves of the tissue on either side, so that under a low power, almost a tree-like appearance was seen. It is this that is referred to and figured by Warren. In all cases the great excess of fibrous tissue making its way where the induration extends, even close under the free surface of the granulations, was remarkable.

In fine, the author agreed with English observers generally, in the non-epitheliomatous character of rodent ulcer, but thought that the great excess and peculiar situation of fibrous tissue as much a distinctive mark as any peculiar grouping of the cells, and ventured to suggest that the so-called nests of epithelium described by some may only have been normal epithelium, e. g. of hair follicles, very obliquely cut.

Mr. Fred. Durham expressed his belief in rodent ulcer being a small-celled growth and non-epitheliomatous.

Mr. Giles quoted an instance of normal epithelium having been mistaken for nests of epithelium in a sarcomatous growth.

Mr. Henry Morris, rather from the clinical aspect of the disease, considered rodent ulcer as quite distinct from epithelioma, though not able to say what microscopic diagnostic character it might possess. He had only that day examined a case of thirteen years' duration that had excavated the face, and he had found a markedly tubular arrangement of the cells, similar to the cases described by Mr. Hulke and referred to in the paper.

Quekett Microscopical Club.

Ordinary Meeting, November 24, 1876.—Henry Lee, Esq., F.L.S., President, in the chair.

A paper by Mr. C. F. George, "On a Species of *Argas* found in the Roof of Blyborough Church," was read by Mr. Curties. This was at first considered to be *Argas reflexus*, specimens of which had been found in Canterbury Cathedral, but it was finally determined to be *Argas Fischerii*. Its mode of introduction was doubtful, as it might have been brought in the pine timber with which the roof had been repaired, or by the bats which sometimes frequented the church. It was suggested that much interesting information on the subject might be obtained by the examination of old roofs that were being taken to pieces. The paper was well illustrated by drawings and specimens.

Mr. Charles Stewart gave a lecture "On the Histology of Skin," in which he traced its development from the simple cell and the growth and structure of the dermal membrane of sponges, through its various modifications in echinoderms, mollusks, fish, reptiles, birds, and mammals. Mr. Stewart's admirable diagrams in coloured chalks upon the black-board added to the interest of the lecture, which was highly appreciated by the members.

Ordinary Meeting, December 22, 1876.—Henry Lee, Esq., F.L.S., President, in the chair.

Mr. Henry Crouch read a paper "On Microscopy in the United States of America," giving some interesting details of a recent tour in that country, and of the microscopes, &c., exhibited at the Centennial Exhibition at Philadelphia. He also exhibited some beautiful specimens of vegetable tissues prepared by Dr. J. G. Hunt, of Philadelphia. Some of these showed the structure remarkably well by the aid of double staining with aniline dyes.

San Francisco Microscopical Society.

The semi-monthly meeting of the Microscopical Society was held in the new rooms, December 7, with Professor William Ashburner in the chair.

Mr. H. C. Hyde donated one of Zentmayer's amplifiers, for doubling the magnifying power of any combination of eye-pieces and object-glasses, which was adjusted by him during the evening, and its capabilities favourably tested.

A letter was read from Mr. Charles Stodder, of Boston, giving further information relating to the use of Wenham's reflex illuminator; and Dr. F. H. Engels also addressed the Society concerning a sample of fresh-water diatoms obtained by him in a stream near American Flat, Nevada, which he sent, asking for an exchange in the way of marine diatoms, &c.

Mr. G. A. Raymond produced some considerable interest in a somewhat common curiosity known as jumping beans, which came from Alamos, Sonora, Mexico, from the fact that he had been fortunate enough to get not only the chrysalis of the insect, the larva of

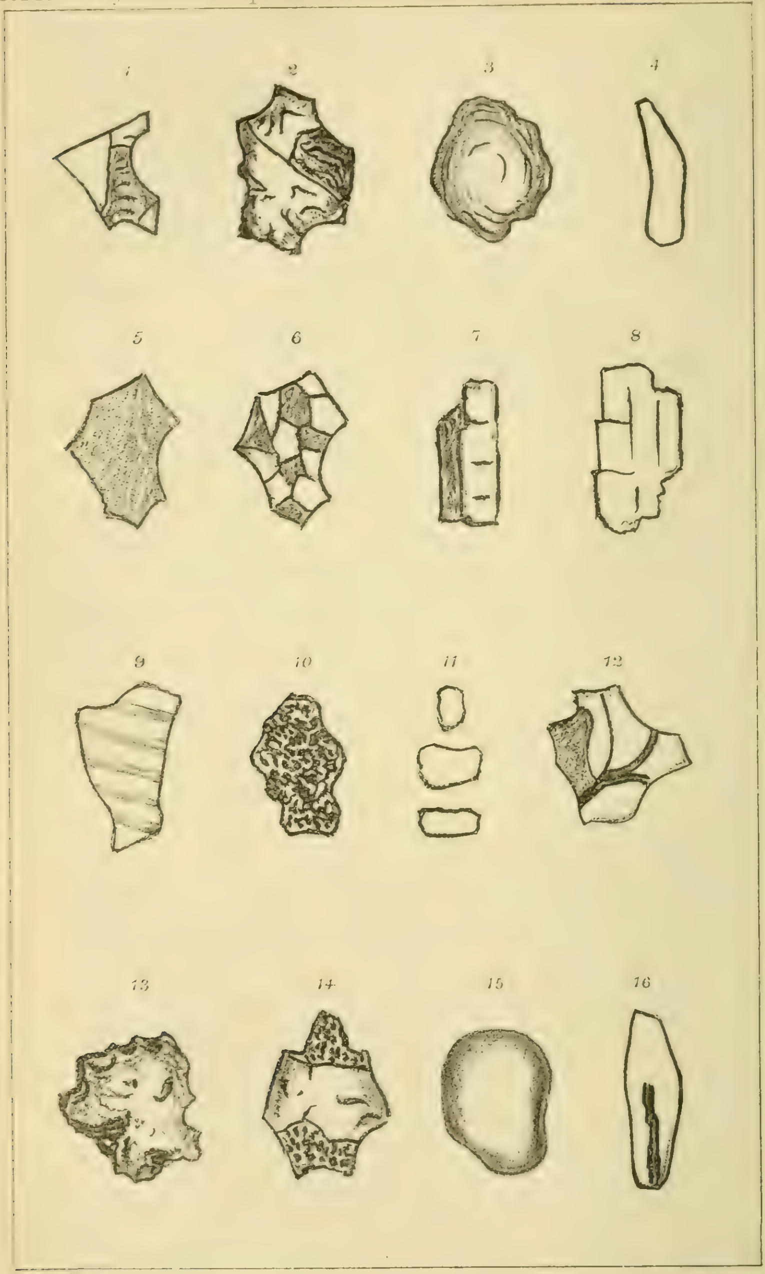
which, within the bean, causes the motion, but the perfect insect itself. Mr. H. Edwards, who was present, stated that he had never seen the insect before, as they had failed to arrive at such perfection in his hands, and his idea that it was a coleopterous insect was dispelled, for the little-winged, moth-like body was one of the Lepidoptera, without question. The matter was referred to Mr. Edwards for examination and report.

Mr. Hanks was asked to report on a sample of so-called silver mud, presented by Mr. G. L. Murdock, and obtained from the silver springs lately discovered in Wasco County, Oregon. The sample gives a chemical assay of over $3000 to the ton, and it will be interesting to see what the microscope has to say about it.

Mr. Hanks presented two specimens of minerals, being gold in hematite and talcose rock, from the Black Hills, Wyoming, a peculiarity being noted in the extreme fineness of the gold.

Mr. Hanks also called attention to an interesting mineral which is only known to occur on the Pacific coast. It resembles scheelite, in which a part of the lime is replaced by oxide of copper. Professor Whitney, who first described it, has named it cupro scheelite. This mineral affords an example of the importance of the microscope in determinative mineralogy. When first discovered it was thought to be a mechanical mixture of scheelite with some copper mineral; but upon a careful examination under the microscope it was found to be perfectly homogeneous. Subsequent discovery of crystals of cupro scheelite proved it to be a distinct and new species, as shown by the microscope. One peculiarity of this mineral is the ease with which the tungstic acid it contains can be isolated. Tungstic acid, combined with soda, forms tungstate of soda, the solution of which renders cotton cloth incombustible. It was suggested by Mr. Hanks that if tungstic acid could be produced cheaply, the theatrical managers could afford to prepare the cotton upon which their scenery is painted, and thus greatly lessen the danger from fire. Cupro scheelite is said to occur in considerable quantities both in Upper and Lower California.

Mr. J. P. Moore exhibited a number of sheets covered with duplicate impressions of a drawing made from the microscope, with a new device, known as Zuccato's papyrograph. He explained the simple process of the manipulation of the pen, ink, and peculiar paper on which the drawing is made, and suggested that scientific and other papers could be rendered more valuable by this system of multiplying the drawings of objects which might be referred to in any paper read before the Society.



W. West & Co lith.

Grains of sand, clay &c.

Magnified variously from 30 to 3000 linear.

THE

MONTHLY MICROSCOPICAL JOURNAL.

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I.—ANNIVERSARY ADDRESS OF THE PRESIDENT,

H. C. Sorby, F.R.S., &c.

(*Delivered before the* Royal Microscopical Society, *February* 7, 1877.)

Plate CLXXIV.

Table of Contents.

Introduction.

Before commencing the special portion of my address, I think I may venture to congratulate the Fellows on the general condition of our Society, and on the proceedings of the past year. We have had a considerable number of valuable communications, followed by very satisfactory discussions. For my own part, I have been

gratified with the fact that so many of these papers were devoted to important general questions, and were not confined to individual observations, having no apparent bearing on any of our great scientific theories. After the reading of these papers I in most cases endeavoured to express my own opinion on the various subjects, and I therefore think it less desirable to again pass them in review, than to direct your attention to a special branch of research with which I have been occupied during the last half year.

The Application of the Microscope to Geology.

Our late distinguished Honorary Fellow, Ehrenberg, was the first to apply the microscope to any considerable extent to the study of geological questions. He, however, directed his attention mainly to the organic constituents of rocks. The general structure of hard stony masses has lately been much studied both in England and on the Continent, especially that of various igneous rocks, or of highly altered strata which more or less closely resemble some of them. So far as I am aware, very little has been done in the application of the microscope to the investigation of the nature and origin of loose and unconsolidated sands and clays. I was led to study these in full detail, because it appeared to me desirable to thoroughly understand the characters of the raw material before attempting to speculate too freely on the nature, extent, and cause of the changes which have subsequently occurred during consolidation or metamorphism. I was also led to examine certain questions more fully on account of having undertaken to investigate and describe the mineral constituents of the deep ocean deposits brought back by the 'Challenger.'

Seeing, then, that this great subject had hitherto been so much neglected. and is yet the very foundation of our knowledge of the history of those rocks, which constitute a large part of the accessible framework of our globe, it appeared to me desirable in my address this evening to attempt to treat this subject in a systematic manner, combining together some well-known facts with others that have perhaps attracted little or no attention, in order to make the whole more continuous and complete. Time will not, however, allow of my entering into full detail, and will compel me to confine my remarks to one principal question.

Structure of Stratified Rocks.

The study of the microscopical structure of stratified rocks is very naturally divisible into two very distinct questions, viz. the nature and origin of the materials which were deposited, and the changes which have occurred since deposition; but on the present occasion I must confine myself almost entirely to the former of these two divisions.

In examining each particular deposit two different questions present themselves. It is necessary, in the first instance, to identify as accurately as possible the mineral nature of the various large or smaller particles, and in the second place to determine as far as is possible the true nature of the rock from which they were originally derived. Thus, for example, if we were studying some modern sandy mud, it would be necessary to identify the grains of quartz, felspar, mica, and hornblende, and the minute granules derived from more or less completely decomposed felspar; but after this preliminary step another important question presents itself. It is very desirable to determine the nature of the *previously existing rocks*, which, when decomposed and broken up by various chemical and mechanical actions, gave rise to the particles of the mud under examination. When this can be successfully accomplished, the history of a comparatively modern deposit may be indefinitely extended into remote past epochs. In a similar manner the study of the ultimate constituents of the very oldest stratified rocks might enable us to form some opinion respecting the nature of still earlier rocks, of which no other record may remain. If this could be done successfully we might, as it were, sometimes trace back the genealogy of our globe a generation or more earlier than by other means. This appears to me a question of so much interest, and its solution so dependent on microscopical investigations, that I venture to bring it before you in some detail, even although the conclusions have a more direct bearing on geology than on those branches of science which usually claim the attention of this Society.

Preparation of the Objects.

When stratified rocks are sufficiently hard and consolidated to be made into thin and partially transparent sections, many facts may be better seen in slices cut perpendicular to the stratification than by attempting to disintegrate the rock and examine the detached particles. It would, however, often be difficult or almost impossible to prepare satisfactory thin sections of many modern or ancient deposits, and it thus becomes necessary to study them in another manner. If the particles are firmly held together by calcic or ferrous carbonate, or by any of the oxides of iron, they may be set free by the action of cold dilute hydrochloric acid, or by a stronger hot solution; but if, as often happens, the rock is consolidated by means of silex, this cannot be accomplished. Violent mechanical crushing must be avoided, since it would give rise to false results by fracturing the constituent grains. Such an amount of crushing as can be effected with a small stiff brush made with bristles does, however, appear to be admissible, since it could scarcely break the separate fragments. Even in the case of

modern unconsolidated clays and muds it is very often difficult to completely separate the ultimate particles when the material has been dried. The finer granules cohere together and form compound larger granules, which might easily be confounded with objects of a different nature. It is therefore often desirable to mix up small quantities of such material with a little water by means of a small and somewhat stiff brush, so as to separate the detached granules without breaking up any truly compound grains. A portion of this may then be sufficiently diluted with more water, placed on a glass slip with a projecting ledge, and covered with a piece of the usual thin glass. By this means the larger particles are seen separate, but the smaller have a very great tendency to mass themselves together by a sort of mutual cohesion. Since the index of refraction of the various grains is in all cases considerably greater than that of the surrounding water, the outline of even the most transparent constituents is well seen, but at the same time this difference in refractive power may make it impossible to study the internal structure or optical characters of the larger grains. This difficulty is overcome by mounting in Canada balsam, which has so nearly the same index of refraction as that of many of the constituent grains that, even when their outline is as irregular as possible, light passes through them almost as though they were thin slices with parallel polished surfaces. This enables us to study the external staining, internal structure, and optical characters to great advantage, since they are not interfered with by any dark shading due to the bending of the light out of the line of vision. When examined in water there is no difficulty in recognizing extremely minute granules of the kaolin of clays, whereas when mounted in balsam they may be almost or quite invisible: but this very circumstance is of great advantage in observing certain facts, since by making them invisible other objects may be distinctly seen which otherwise would be completely hid by the surrounding granules.

Though, in order to obtain a knowledge of the general character of the deposit and the variation in size and relative abundance of the different constituents, it is best thus to examine deposits as a whole, a mixture of very coarse and very fine particles makes it difficult to study in detail either to perfection. It is therefore often desirable to separate the coarse or finer sand from the still finer granules of clay, which may be effected by suspending the material in water, and allowing the sand to subside, whilst the whole is gently agitated so as to prevent the cohesion of the particles into the compound grains described in a subsequent part of this address.

Mounting Deposits in Balsam.

In mounting the loose sandy deposits in Canada balsam I have found it a great advantage to adopt the following plan:—Having placed a very small quantity of dissolved gum on the glass plate, the requisite amount of the deposit is taken and mixed with the gum and sufficient water to make it easy to separate the grains and spread them uniformly over the space which will afterwards be covered by the thin glass. The water is then allowed to evaporate slowly, and though much of the gum collects round the margin, by properly regulating the quantity originally added enough remains under the larger grains to hold them so fast that they are not squeezed out with the excess of balsam. More gum than is sufficient for this purpose should not be used, since it may make itself too conspicuous in the object. When the proper quantity has been used, its presence can be detected only at the under surface of the grains, and in that situation does not in any way interfere with the study of the object. Independent of the convenience in mounting, this method prevents the grains from settling to one side of the object, even when soft balsam is used, which is desirable, since it penetrates more completely at a lower temperature into irregularities of the surface and into the interior of compound grains than when harder.

Visibility of the Objects.

Some of the separate grains, or those enclosed in transparent minerals, do actually absorb a considerable part of the light transmitted through the object, and are therefore visible as black or coloured particles, quite independent of the angle of convergence of the light, and of the aperture of the condenser or object-glass. Many of the particles are, however, composed of quartz, mica, felspar, or other colourless and transparent minerals, and when in water or balsam are made visible mainly by a portion of the light transmitted through them being so bent out of its course that it does not pass up to the eye-piece. This is especially the case with the more or less curved edges of the grains, and with suitable illumination they thus show a dark outline. The same principles apply to fluid cavities in minerals, and to the accompanying bubbles. The width of the dark margin depends on the difference in the refractive power of the particle and of the surrounding medium, and if this difference be small, no such outline may be seen, if the angle of convergence of the light be at all considerable. Thus, if the aperture of both the object-glass and condenser is large, and the grains are mounted in Canada balsam, little or no trace of them may be visible, but by reducing the aperture their outline becomes more and more distinct, and the shading greater and greater, until

in certain cases it may become so dark as to obscure certain characters. It is therefore of the very greatest importance to have the means of varying the angle of deviation from a direct line, which in ordinary microscope apparatus is the most readily effected by a diaphragm below the condenser. In the case of very fine particles of such substances as pumice, which play an important part in the material obtained from great depths in the Atlantic and Pacific oceans, the outline can scarcely be seen with an object-glass of even moderate aperture, when they are mounted in balsam, if the light used for illumination be *convergent*, but is seen to very great advantage when illuminated by the *divergent* light obtained by using a concave lens instead of the usual convex condenser, that is to say, following out the usual nomenclature, when the aperture of the condenser has a negative value, or, so to say, is considerably less than nothing. We are, however, limited to low powers, by the light being made too feeble for high.

Object-glasses used.

The facts just described will make it very obvious that in studying deposits there is no advantage in having object-glasses of large aperture, but a positive disadvantage. When the light transmitted is so convergent that the full aperture is utilized, the object becomes almost, or quite, invisible from the absence of any dark outline, and the focal point of such lenses being so near to their front surface it is quite impossible to penetrate sufficiently deep down to see the minute fluid cavities in the centre of grains of sand, or to reach the fine particles lying on the surface of the glass slip, below the thickness of balsam necessitated by the presence of large grains of sand. For these researches Messrs. Beck have made for me a $\frac{1}{8}$th of only 75° of aperture, constructed, however, with all possible care, and I find it extremely useful, since I can easily reach all parts of the object, and can obtain perfect definition with the power of about 600 linear requisite to identify the extremely minute fluid and glass cavities. I can also see the form of grains as small as $\frac{1}{50000}$ of an inch in diameter. Such cavities and particles are excellent tests for those qualities in object-glasses necessary for the present inquiry, since we know what we ought to see. Very few objects occur less than those named, and even at that size we seem to have arrived at the limit allowed to us in such cases by the properties of light itself. If this were not the case, we ought to see a bright speck in the centre of the bubbles in the minutest fluid cavities; but none can be seen when, calculating from the diameter of the bubble, the central bright speck ought to be less than $\frac{1}{600000}$ of an inch in diameter. A $\frac{1}{8}$th, with an aperture of 120°,

does not enable us to exceed this limit, for reasons already explained. The value of the larger aperture in studying an entirely different kind of object is another question altogether.

On the Microscopical Character of Sands and Clays.

In studying loose and unconsolidated sands and clays little or nothing can be learned respecting the structural arrangement of the particles. Our attention must be almost entirely confined to their mineral nature, external form, and internal structure. The determination of some facts is certainly facilitated by our being able to study detached particles; but the observation of other facts is made more difficult by our not being able to examine transverse sections of the individual grains. In any case we are obliged to make use of materially different methods of study, and must rely on different classes of facts. I feel very strongly how imperfect the whole subject still is. I have had great difficulty in obtaining suitable material, since, as a rule, such specimens as are of the greatest interest in connection with this investigation are seldom collected, and I have been obliged to rely almost entirely on what I collected for myself some years ago for this special purpose.

Origin of the Material.

In studying any particular stratified rock it would usually much assist us in forming a true opinion respecting its formation, if we could ascertain the previous history of the material of which it is composed. Thus in the case of limestones it is desirable that we should know the exact nature of the calcareous organisms, which, by being broken up or decayed, yielded calcareous sands or muds, since consolidated into hard rock. Very often this may to a great extent be learned from the organic structure characteristic of various groups of shells or corals. In some of our stratified rocks we meet with larger or smaller fragments of previously existing rocks, and even some of the oldest slates in Wales are seen with the microscope to be, as it were, museums of specimens of the rocks existing at the time of their deposition. The further study of this branch of my subject may probably enable us to prove that these ancient Welsh slates were in part derived from previously existing strata, which were themselves derived from still earlier rocks; but time will not allow of my entering into this question. I purpose to limit myself to those facts which show the nature of the rocks which, when decomposed and broken up, yielded the detached grains of sand or other mineral particles subsequently deposited and consolidated. So very little attention has been paid to

this question that perhaps some geologists may be disposed to doubt the possibility of determining it in a satisfactory manner; but, though we cannot learn all that we could wish, the form and the internal structure of the individual grains of sand or finer particles of mud are often sufficiently characteristic to enable us to draw several important conclusions. We may thus ascertain whether the greater part of the deposit was derived from the decomposition of slates, schists, or granitic rocks; and in the latter case we may sometimes form a very satisfactory opinion respecting the general characters of the parent granite. In order to show how it is possible to learn these particulars, it will be necessary to describe in detail the various characters of the principal mineral constituents of the rocks now under consideration.

Quartz.—The grains of quartz, which are the chief constituent of most sandstones, and occur in greater or less number in nearly all shales and slates, have been derived principally from granitic or schistose rocks, broken up by the action of currents of water, after having been more or less decomposed by the action of the atmosphere. The form and internal structure of those derived from granite may be learned by studying thoroughly decomposed specimens of that rock. By washing and sieving it is easy to separate from the decomposed felspar the sand of coarser or finer grain, which in addition to quartz contains mica, and more or less imperfectly decomposed felspar.

Quartz in Granite.—The form of the quartz grains is extremely irregular; but in most cases they are not much longer in any one direction than in another, which is due to the structure of the granite itself being nearly the same in all directions. Usually the grains are very angular, but some have such a rounded outline, that, if their origin were not known, they might be supposed to have been much worn by the action of water. The general character will be better understood by referring to Plate CLXXIV., which in Figs. 1 and 3 gives examples of the extreme types, and in Fig. 2 a more common shape.

The irregular angular outline is due to the mutual interference of the individual imperfectly grown crystals, which could not develop true crystalline planes of any considerable extent. The effect of this interference of growth is, however, often visible as small surface ridges, even when the general outline is scarcely at all angular; which thus proves that this exceptional rounded form is due to the peculiar conditions of the growth, and not to mechanical wearing; since in that case all such surface irregularities would have been removed. That each of these more or less irregular grains is a single imperfectly developed crystal can be easily proved by means of polarized light. When they are mounted in Canada balsam,

since its index of refraction is almost exactly the same as that of quartz, light passes through them almost as though they were thin flat sections, polished on both sides. Each grain then shows a simple optical structure, and the colours round the circumference are usually of low orders, which gradually or more suddenly rise to higher orders towards the centre; which proves that the grains are not flat, but thickest in the centre, and more or less angular in their outline, even in a plane parallel to the line of vision.

The internal microscopical structure is also easily seen when the grains are mounted in Canada balsam, and there is no difficulty in using sufficiently high powers. Amongst the more striking characters are the larger or smaller fluid cavities; the hair-like crystals of schorl; and the extremely minute granules or crystals which can scarcely be defined individually, but give rise to a general white milkiness, when the illumination is of such a kind that they appear white on a black background, and is to a great extent due to a vast number of very minute bright specks, many of which are out of focus. The chief variations in the character of different specimens depend upon the size and amount of these various inclosures in relation to one another and to the general mass of clear quartz; but, as in the case of the granites themselves, these variations may be sufficient to distinguish more or less completely those of particular districts, as, for example, the granites of Cornwall from those of Norway or the Highlands of Scotland.

Quartz in Schists.—I have not been able to detect any microscopical character which enables us to distinguish between massive, thick foliated gneiss and granite. There is a most perfect and gradual passage from true and characteristic metamorphic schists to typical granite, in the external form, internal structure, and optical properties of all the constituent minerals. In certain districts where the schistose rocks have undergone extreme metamorphism it thus appears probable that the granite has to some extent been formed *in situ*, by the still further metamorphism of the sedimentary rocks. There is, however, no difficulty whatever in distinguishing between the less highly metamorphic schists and granite, and more especially when the latter rock is undoubtedly intrusive and no longer in the place where it was formed. There is also a gradual passage from schistose to slaty rocks which have undergone very little change since deposition. It is therefore impossible to draw any absolute line of division between rocks which on the whole have a very different structure, and have been formed under very different conditions, and thus the only course open to us is to deduce general laws from the study of characteristic specimens, fairly representing the main masses of each particular class of rocks. This is more

especially desirable in connection with the subject now before us, since in general the more doubtful passage beds would not have a very great influence on the nature of the material derived from the denudation of a large tract of country.

If, then, we compare the microscopical structure of granite with that of a thin foliated mica-schist, cut perpendicular to the laminæ, we find that the difference is very great, independent of the more or less complete absence of felspar. The schist is made up of flat plates of mica, not as in granite lying in every possible plane, but on the whole more or less closely parallel to one particular plane. In the case of rocks having stratification-foliation this plane corresponds to the layer of different mineral character, and thus the thin layers of quartz are often bounded on both sides by layers of flat plates of mica. Even when the amount of this latter mineral is not sufficient to constitute a continuous layer, the detached flakes lie in one plane. The result of this is that the presence of so many parallel flat plates of mica has to such a great extent interfered with the growth of the crystals of quartz, that a very large proportion of them are bounded by flat parallel planes of interference, and thus, instead of having the extremely irregular form of those in granite, they are on the whole characterized by having two surfaces more or less flat and parallel. Fig. 4 will show the general character of the transverse section of the forms thus produced, which thus differ much from those derived from granite shown in Figs. 1, 2, and 3.

When detached and lying flat on glass, their characteristic shape might easily be overlooked, but their flattened form is revealed by using polarized light and an analyzer; since we obtain comparatively uniform tints over their whole surface, instead of tints rising rapidly from the margin towards the centre.

If the foliation be thin, much of the quartz may occur in such flat plates; but if the foliation of the rock be thick, more than one crystalline particle may be and often is developed between the layers of mica, and thus the grains of quartz may more or less completely cease to be of a flattened shape. This is especially the case if the schist possess cleavage-foliation, since then those grains of quartz alone are flat which lie *in* the layers of mica. Those that lie *between* the layers may be of an altogether irregular form, and therefore, if the crystallization be coarse-grained, it might be impossible to distinguish such quartz from that of some granites. It is also impossible in the case of the quartz of the coarse-grained quartzose layers of schists possessing stratification foliation. The result of this is that even in sand derived exclusively from schists a few grains of quartz may be expected to occur which could not be distinguished from grains derived from granite.

Though as far as mere *form* is concerned, the grains of quartz in schist may thus sometimes be very similar to those in granite, yet, on comparing the more common types of these rocks, there is a well-marked difference in other respects. Usually the *size* of the separate crystalline particles of the quartz in granite is much larger than in the case of schists. Those in granite are also usually bounded on most sides by felspar or mica, and thus, when the rock is broken up by decomposition, each of the detached quartz grains is, as it were, part of one single crystal, as already named. On the contrary, those in schist being much smaller and often bounded by similar crystals of quartz, firmly cohering to them on all sides, when the rock is broken up there is only an imperfect separation of the crystalline particles, and many of the resulting grains of sand are of complex character. This difference can be detected by using polarized light with an analyzer. Thus, assuming that the general outline was the same in both cases, in certain positions of the plane of polarization the grain derived from granite would be uniformly dark or coloured over its whole area, as shown by Fig. 5; whereas, if derived from schist, it would present a tesselated appearance like Fig. 6, the detail varying on rotating the plane of polarization. The separate portions may be in such perfect optical contact that this complex structure may be quite invisible if polarized light be not used.

I have not been able to recognize any well-marked difference in the ultimate microscopical structure of the quartz of granite and schists. Minute needles of schorl are on the whole more common in the quartz of granite, but they do also occur in that of many schists. The quartz of some granites also contain a much greater number of fluid cavities than that of most schists, but in the quartz of other granites they are quite as rare as in the purest quartz of any schists; and thus the only safe conclusion is that the presence of many needle-shaped crystals of schorl, or of many fluid cavities, makes it more probable that the quartz was derived from granite than from schists.

Mica, &c.—In comparing the mica from different specimens of schists and granites, there is a similar difficulty in drawing any absolute line as in the case of the quartz. The extremes are distinct enough; but there is every connecting link in passing from moderately altered to very much altered schists, to gneiss and to granite. If it were possible to determine the true chemical and mineral character of the mica in every case, even where two or more different kinds are mixed together, much more could probably be learned; but in the practical study of the microscopical structure of stratified rocks we are almost compelled to content ourselves with what can be learned by means of the microscope alone, and to rely on general

facts, even though they are more or less affected by exceptional differences. For this reason, in studying the micaceous constituents, we are compelled to place far more reliance on mere colour than would be admissible in accurate mineralogy; but still the difference of colour is often so well marked, that it does appear to be characteristic, even although probably the same mineral species may be thus separated and different species united together. It must also be borne in mind that when I speak of mica I do so in a very general sense for micaceous minerals, which may or may not be true mica, and may often be more closely allied to chlorite. I use it in fact in such a sense as is convenient for the purpose now in hand. If we were to be content with nothing short of mineralogical accuracy, it would be necessary to abandon the study in despair. For this reason it is convenient to classify the micaceous constituents as colourless, brown dichroic, and green dichroic.

The colourless varieties appear to occur both in granites and schists, and no reliance can be placed in them to establish any difference. On the whole, the dark brown-red or nearly black dichroic varieties are characteristic of granites or very highly altered schists, whereas the more or less green dichroic are characteristic of less altered schists and slates.

Hornblende and Schorl.—The hornblende of schistose rocks usually occurs in crystals considerably longer than broad, and when broken up gives rise to fragments bounded by parallel sides, with more or less rectangular ends, as shown by Fig. 7.

The colour is usually different shades of green, varying with the position of the crystal, and showing blue-green and yellow-green dichroism. Though sometimes occurring in granitic rocks, hornblende is far more abundant as a constituent of schists in those districts of England and Scotland which I have more particularly examined, and its presence in the associated stratified rocks of more recent date must be regarded as indicating that they were derived more from the decomposition of schists than of granites.

Schorl not having a well-marked cleavage does not break up into such regular shaped fragments as hornblende. The intense dichroism of the coloured varieties is a most important character. On the whole, it may be looked upon as more characteristic of granitic than of schistose rocks, though it is probably in some cases more abundant in the latter than is commonly supposed, and thus no very definite conclusion can be drawn from the presence of detached fragments in sandy deposits.

Felspars.—Except in a few cases where grains of the original felspar sand can still be seen in mica schist, felspars are almost or quite absent from this class of rocks. For the purposes of our pre-

sent subject orthoclase may be looked upon as eminently characteristic of granite and the associated gneiss, and labradorite of the basic erupted rocks. When only very slightly decomposed, fragments may usually be recognized by showing more or less distinct evidence of a well-marked cleavage, like Fig. 8, or, in the case of some species, by the compound banded structure seen with polarized light and an analyzer, as shown by Fig. 9.

When very considerably decomposed, both these characters are lost, and the fragments may be of irregular form, and show only a very fine granular structure, appearing more or less dark and opaque by transmitted light, and white with a more or less red tint by reflected light. Fig. 10 is an example of such a fragment. When completely decomposed, felspar easily breaks up into granules of kaolin. These granules are usually very minute. From $\frac{1}{8000}$ to $\frac{1}{10000}$ of an inch in diameter is a common size, but many occur as small as $\frac{1}{50000}$. Their refractive power is so nearly that of Canada balsam as to make it difficult to distinguish them when mounted in that substance, and they are seen to the greatest advantage when examined in water. It requires some care to clearly make out their form, but, as far as I have been able to ascertain it by making them turn about, they are not, strictly speaking, amorphous, nor yet minute crystals, but somewhat flattened and elongated particles, very similar to those obtained on reducing undecomposed felspar to a fine powder, as though the original crystalline structure had had a very powerful influence in determining the shape of the particles of the more or less pure hydrous silicate of alumina produced by decomposition. As an example of the shape of the particles, I refer to Fig. 11, which is supposed to show an average example of a highly magnified particle seen in various directions. There is, however, a considerable variation in the relative length, breadth, and thickness.

The depolarizing power of kaolin is high, and can be easily recognized in particles as small as $\frac{1}{12000}$ of an inch in diameter. Amongst the granules of decomposed felspar often occur small needle-shaped crystals, the nature of which remains to be determined.

The glassy sanidin of modern volcanic rocks differs very much from the felspars met with in granite; but I must forbear to enter at length into such volcanic products, since they have so little direct bearing on British geology, to which I must chiefly confine my remarks this evening.

Pumice.—For the same reason I need not say much respecting pumice, although it plays such an important part in deep ocean deposits. It has often no action on polarized light, being a true felspathic glass, in the midst of which gas or steam has been given

off, so as to make it consist of little more than a mass of irregular cells with thin dividing walls—a sort of glassy froth. As an example of a fragment, I refer to Fig. 12, in which the shaded parts represent the thin cell-walls seen edgewise.

Iron Oxides.—As a general rule the oxide of iron derived from the decomposition of rocks is the hydrous peroxide. Sometimes the separate granules can be recognized, but it often occurs as a mere staining over the surface or in the interior of the larger fragments, made up of granules too small to be separately defined. We thus obtain various tints of red and yellow, made more or less brown by the presence of the magnetic oxide. In some cases we also have larger grains derived from crystals of this latter mineral which were present in the original rock previous to its decomposition. Changes taking place after deposition may soon alter the amount of combined water, or give rise to ferrous compounds, or to pyrites, and completely alter the colour of the rock, and may thus greatly obscure the relation between modern and more ancient deposits.

General Conclusions.

Taking into consideration all the facts described above, I think we are able to draw the following general conclusions. On the whole, the particles derived from the decomposition and breaking up of granitic rocks are sufficiently different from those derived from schists to make it possible to decide to which of the more usual types of those two classes of rocks they should be referred. When we come to study individual particles, many may be found which show the characteristic differences so very imperfectly that it may be impossible to determine their origin in a satisfactory manner. In examining any particular deposit, we must consider whether the relative amount of such doubtful cases is greater than would correspond with the amount of those clearly indicating that they were derived from granite or from schists. Thus, for example, if the great bulk of the material is like particles derived from schists, the presence of a few grains of quartz which *might* have been derived from granite may safely be attributed to the thicker folia or quartzose aggregations in the schists; whereas, if the great bulk is made up of particles like those derived from granite, the presence of a few doubtful grains may be ascribed to exceptional variations. We must, however, of course be prepared to find that many stratified rocks have been formed from material derived from both sources; and, on the whole, the only safe conclusion is to say that they have been mainly derived from one or the other, or from both in some simple proportion, which can be only approximately known.

In order to assist such determinations, it will be well to express the necessary data in the following tabular form :

	Granite.	*Schists.*
Larger grains	Some may show felspar attached to the quartz.	Some may show quartz enclosing plates of mica lying parallel to the external surfaces.
Quartz—		
General form	More or less equiaxed ..	More or less flattened.
Optical structure ..	Simple	Often complex.
Mica	Brown dichroic	Green dichroic.
Felspar	Unaltered or decomposed into kaolin.	Absent.
Hornblende	Comparatively rare ..	Comparatively abundant.
Needles of schorl enclosed in the quartz.	Common	Much more rare.

Sorting of the Material.

In studying stratified rocks it is most essential to understand the general laws concerned in the sorting of material suspended in water, or drifted along the bottom by currents. When a grain of sand or a flake of mica subsides in water, the accelerating force of gravitation soon becomes equal to the resistance, and then the particle subsides at an uniform rate, called its *final velocity*. The actual amount of this final rate varies directly as the density of the material, and inversely as the size of the grains; but the law is made somewhat complicated by a variety of circumstances, amongst which may be named the shape of the grains. In accordance with this law very minute and perfectly detached particles subside very slowly, and I find that the smallest granules of kaolin in clay subside at the rate of about one foot in five days, whereas grains of sand $\frac{1}{100}$ of an inch in diameter subside a foot in about ten seconds. If then there were nothing to interfere with this law, the very fine particles of clay would seldom occur mixed with grains of sand. Such a complete separation is, however, very unusual, and as a general rule clays consist of particles of extremely various size. This can be easily explained by the very peculiar physical characters of kaolin. When suspended in water, the particles have a very great tendency to stick together and collect into complex granules, somewhat like mist collects into drops of rain, and in so doing may enclose grains of sand. The rate of subsidence is therefore not that of the *separate individual particles*, but that of the complex granules, which is tolerably uniform for all of them. It is much more rapid than that of the separate minute particles would be, since, compared with the surface, the weight of large particles is greater than that

of small; whilst at the same time the rate of subsidence is less than that of the separate grains of sand would be, since the resistance of the water is necessarily greater for such unconsolidated granules.

This collecting together of compound granules depends very much on the amount of material held in suspension. and also on whether the water be quite still or agitated; and we can, I think, thus easily explain why in some cases so much sand is mixed with the clay, whilst in others the separation is far more complete; and can also explain the transport of material containing fine sand over very wide oceanic areas, to places far removed from the source of supply.

Practical Application of the above-described General Principles.

In studying loose deposits of sand or clay, whether in water or in Canada balsam, we must bear in mind that the particles will almost invariably rest with their flattest surfaces on the glass. The result of this is that their flattened character might very easily be overlooked. When examined in water much may be learned by observing the effect of change of focus, and also by making the grains turn round by slightly moving the covering glass; but when mounted in balsam the difference is best shown by the action of polarized light, with an analyzer. If a grain of quartz or any other doubly refracting mineral be thick and of irregular form, the tints will rise rapidly and irregularly from the margin towards the centre, whereas if it be flat there will be an almost uniform tint over the whole surface.

Identification of the Constituent Minerals.

Quartz.—This may be best recognized by means of its irregular outline and the absence of anything like cleavage planes; by its index of refraction being so nearly the same as that of Canada balsam, that, when mounted in this substance, there is scarcely a trace of shading round the exterior outline; and by the general intensity of its action on polarized light. This of course varies with the inclination of the principal axis, but when in the ordinary average position in which the grains are seen, those of moderately uniform diameter in all directions give the following results:

Grains of $\frac{1}{30}$ of an inch in diameter or upwards seldom show bright colours except at the edges, the tint of the centres being pale reds and greens.

Grains of about $\frac{1}{100}$ of an inch in diameter show the brightest orders of colours.

Grains $\frac{1}{1000}$ of an inch in diameter show only the pale bluish white of the first order, or the complementary brown.

Calcite, &c.—Crystallized calcite may be at once distinguished from quartz by the more or less conspicuous planes of cleavage. This will not, however, apply in the case of fragments of calcareous organic bodies. Since the index of refraction is considerably greater than that of Canada balsam, their outlines are tolerably well marked, when mounted in that substance. The action of calcite and arragonite on polarized light being so powerful, the bright orders of colours are best seen when the fragments are about $\frac{1}{2000}$ of an inch in diameter, and when more than $\frac{1}{1000}$ we usually obtain the faint reds and greens of high orders or merely white light, distinguished from the bluish white of the first order by not giving the complementary brown. When examined in water all doubt can be removed by observing the action of dilute hydrochloric acid, which dissolves calcite and arragonite with effervescence, and leaves quartz and many other minerals unchanged.

Mica.—This is best recognized by its occurring as thin plates having a laminar structure. When in water or mounted in balsam the flat surfaces lie parallel to the supporting glass, and it may be somewhat difficult to appreciate their thickness and to distinguish them from flat plates of quartz. If they cannot be made to turn round, so that their edges may be seen, the only course that can be adopted is to illuminate carefully and observe the effects of slight changes in focal adjustment, which may suffice to prove that the fragments are flat and have a laminar structure, with no cleavage in any other direction. The occurrence of small granules or crystals of red oxide of iron between the laminæ may sometimes greatly assist in forming a satisfactory conclusion, since a perfectly flat thin layer of any such material is not at all likely to occur in quartz. Advantage may also be taken of the difference in refractive power, as described below when treating on glassy felspar.

Hornblende, &c.—What I have said when describing the hornblende and schorl in decomposed rocks will, I think, sufficiently explain the methods I have employed in identifying them in deposits. Perhaps the most decided difference between coloured hornblende and schorl is the intense dichroism of the latter, so that in certain positions no light passes through it.

Felspars.—As a general rule the difference between the felspars in granitic and in volcanic rocks is so great that it may be convenient to consider them separately. Those in granitic rocks are almost or quite free from cavities, or at most contains only a few fluid cavities, whereas the glassy sanidin of volcanic rocks often contains many well-marked glass cavities. It also differs greatly from other felspars in various ways. Thus, whilst the orthoclase of

granitic rocks shows with polarized light coloured bands due to twin plates, and abite, oligoclase, and labradorite give more or less well-marked evidence of their cleavage, the sanidin of modern volcanic rocks often occurs as clear transparent fragments, having a simple optical structure, and showing no more lines of cleavage than a piece of glass.

On the whole, fragments of unaltered felspar constitute but a very small part of our British stratified rocks, and glassy felspar is probably almost or quite absent; but when we come to study the modern deposits formed at great depths in the Atlantic and Pacific oceans, we find that it plays a most important part. For some time I feared that no ready means could be discovered to distinguish between it and quartz. Both break up into irregular transparent fragments, having a vitreous fracture, and, when of the same size, give with polarized light the same tints, so that these minerals cannot be distinguished by that means. At length, however, it occurred to me that perhaps there might be sufficient difference in their refractive power to cause them to appear different with suitable illumination. As previously named, the refractive power of quartz is almost absolutely the same as that of moderately fresh Canada balsam, but I find that it is decidedly less than that of very hard balsam. On the contrary, the refractive power of glassy felspar is equal to that of this very hard balsam, and greater than that of new and soft. Hence when both minerals are mounted in soft balsam, transmitted light passes so evenly through the quartz as to show little or no dark outline, whereas in passing through the glassy felspar it is somewhat bent, and if the apertures of both the condenser and object-glass are sufficiently small, the fragments show a dark outline. The difference is, however, scarcely so well marked as is desirable, and it is therefore better to make use of a different illumination. By using a condenser with a central stop, so as to get a black background, the oblique rays pass through the quartz without there being any light reflected, and the outline is invisible, or only shown by means of any superficial coating of some other material which may be present. There is, however, seldom any difficulty in distinguishing this from true surface reflexion. On the contrary, the glassy felspar having a somewhat higher refractive power than the soft balsam, reflects part of the light, and causes the fragment to show a well-marked bright outline. As far as I have been able to judge, this method gives satisfactory results, which are confirmed by other facts. Thus, for example, on examining some of the sandy matter washed from the deep ocean clays brought back by the 'Challenger,' I came to the conclusion that certain particles were quartz and others glassy felspar, and on examining these with a much higher power I saw that what

I had thus found to be quartz contained the usual fluid cavities, with moving bubbles, whilst what I had concluded must be felspar contained the well-marked glass cavities of modern volcanic rocks.

There is little chance of confounding felspar and quartz in studying British stratified rocks. The only fear is of mistaking for one another fragments of decomposed felspar and portions of stratified rocks formed of thoroughly decomposed felspar, consolidated after deposition as separate granules.

Kaolin, &c.—The principal characters of this substance have been already described. It may in general be identified by the more or less elongated and flattened shape of the particles, and by its strong depolarizing action, which, with crossed Nicols, suffices to give a pale bluish white, even when the particles are $\frac{1}{13000}$ of an inch in diameter. There is no chance of confounding them with minute particles of quartz, which to give such a tint must be about four times that diameter. There is also no difficulty in distinguishing kaolin from decomposed or comminuted pumice and some other analogous modern volcanic products, since the form of these particles is very different, and they have little or no action on polarized light. There is also no difficulty in distinguishing between true kaolin and the minute short needle-like crystals met with abundantly in some decomposed volcanic rocks, since their shape is so different.

Application of similar Principles to thin Sections of Rocks.

As an almost universal rule thin sections of stratified rocks should be cut in a plane perpendicular to the stratification. In this case the thin flat plates of quartz or mica are almost always seen in transverse section, and the fact of their being thin and flat is at once apparent. There is also little difficulty in distinguishing between the thinnest pieces of quartz and the flakes of mica. These latter are usually thinner and of more uniform thickness, and with proper illumination and a sufficiently high magnifying power the laminar structure of the mica may be easily seen. Its colour and dichroism are also important characters, and observed to the greatest advantage in transverse sections. The identification of the various other minerals may be accomplished in the manner already described, and the only point that needs special attention is the recognition of the very minute granules of kaolin or micaceous substances disseminated amongst the larger fragments, which may, however, be accomplished by carefully regulating the aperture of the condenser, which must be small.

Application of the above-described Principles to Special Cases.

The practical application of the general principles already explained will, I think, be more readily understood if I describe a few characteristic examples of various natural deposits.

Millstone Grit of South Yorkshire.—It would be difficult to find a better example of a coarse-grained sandstone, almost entirely derived from granite, than the above-named rock. Some of the beds can easily be broken up into loose sand, and the structure of the grains observed when mounted in balsam. With very few exceptions they are extremely angular, as shown by Fig. 13, and in every respect identical with grains of quartz derived from decomposed granite. Grains of unchanged felspar do sometimes occur, but the greater part has been decomposed into clay, which has been squeezed into the spaces between the grains of quartz. In some few cases portions of felspar may still be seen adhering to quartz, as shown by Fig. 14, which may therefore be said to be actual grains of granite. The quartz is on the whole very free from fluid cavities, and more like that from the granites of Norway than from any British variety which I have examined, and certainly very unlike that from the Cornish granites. These conclusions agree admirably with other facts. In the associated pebble beds portions of undoubted granite may be found. It is of coarse grain, with comparatively clear felspar, quite unlike the usual varieties met with in Scotland or Cornwall, but closely like those from Norway. The current structures of the rock clearly show that the material was drifted from the north-east, and it was probably derived from granitic rocks lying at no great distance in that direction. Even the much finer grained quartzose sand beds, like the gaunister, have apparently been mainly derived from granitic rocks. We need not go far to find the other constituents of the granite. Mica abounds in some beds, and the decomposed felspar has no doubt largely contributed to the material of the associated shales and indurated clays. Nearly all the grains of quartz are as angular as if never subjected to attrition ; but a few are so much worn that they may have had a different history—they may have been exposed longer to wear, or may have been derived from dunes of blown sands.

Sand of the Egyptian Desert.—This is a splendid example of a sand which has been very much worn by attrition, as shown by Fig. 15, all angles being removed. Ordinary dune sand shows the same kind of wearing in a less degree. When blown about by the wind the friction of the grains one on another is necessarily much greater than when they are to a considerable extent buoyed up in water, and there is thus no difficulty in understanding

why so many have been far more worn and rounded than the grains met with in subaqueous deposits. Both in them and the sand of the Desert, other things being equal, the amount of wearing is greater in the case of the larger than in the case of the smaller grains, which is easily explained, since their weight and the amount of friction would necessarily increase in higher proportion than their diameters. The contrast between this sand of the Desert and equally coarse sand from the Millstone Grit is most striking, as will be seen on comparing Figs. 13 and 15, and points most clearly to a very different history, although the material was in both cases originally derived from granite.

Sand derived from Schists.—On the sides of the valley of the Tay, north of Dunkeld, occur terraces of sand at some elevation above the river. This sand is fine-grained, the common size of the grains being about $\frac{1}{200}$ of an inch. There is no difficulty whatever in seeing that a very large proportion are flat plates, either by making them turn round in water, by carefully studying their appearance when the focus is slightly changed, or by examining their action on polarized light, when mounted in balsam. Fragments of dark green hornblende are common. Since we cannot examine sections of the mica in the proper direction, its dichroism cannot be observed, but some of the darker flakes may have been derived from granitic rocks or highly altered schists. On the whole, the microscopical characters clearly indicate that the great bulk of the deposit was derived from schists; and, considering the geological character of the surrounding country, there can be little doubt about the accuracy of this conclusion.

In the neighbourhood of Moffat and of Bangor occur hard slate rocks without cleavage, which can easily be cut into thin sections perpendicular to stratification. These show alternating layers of coarser and finer grain, and of red or pale green colour. The grains of quartz sand in the coarser layers are seldom $\frac{1}{100}$ of an inch in diameter. Those of $\frac{1}{200}$ to $\frac{1}{500}$ are common, and many are $\frac{1}{1000}$ or less. A large proportion of these are flat plates, like those derived from schists, and in some cases they enclose plates of mica parallel to their longer axis, as shown by Fig. 16, the shaded part being the mica. Such a grain may be looked upon as a fragment of mica schist. The quartz is usually broken up into such small fragments that only a few show complex structure. Well-marked grains of green hornblende occur, and a good deal of green dichroic mica. There are, however, a few which are dark dichroic, and in the very fine-grained layers are many minute granules, having all the characters of those derived from felspar or other minerals of granite rocks

which decompose into similar material. Taking all these facts into consideration, there can be no reasonable doubt that a very large portion of these rocks has been derived from schists, which has been deposited along with a little mica and many very fine granules, derived from perhaps more distant granitic rocks.

It appears to me scarcely necessary to describe any other special cases. As far as I have been able to ascertain from an examination of sandy deposits belonging to nearly every period of our British stratified rocks, I think we may conclude that, as a general rule, the coarser-grained sands are mainly derived from granitic, and the finer from schistose rocks; which is no doubt because the separate solid fragments of quartz in granite are usually much larger than those in schists. Even the oldest slates which I have examined thus furnish evidence of the existence of still earlier strata, subsequently metamorphosed. One thing which may appear somewhat surprising is that on the whole the grains of sand are very little worn, and hence the finer-grained sands have not resulted from the wearing down of larger grains, but consist of particles which were originally small, separated from the larger by the action of currents. That part of the quartz worn off from the rounded grains is probably met with in the clays mixed with the true kaolin. It seems scarcely possible that the larger solid grains could be reduced to smaller by simple fracture, by the action of currents.

The microscopical structure of the quartz enables us to form some idea of the general character of the granitic rocks which have yielded so large a part of the coarser sands met with in British strata. They must certainly have been very unlike the Cornish granites, since the quartz of these latter contains a far greater number of fluid cavities. They must have been much more like the granites of the Scotch Highlands or those of Norway, and perhaps we should not be far wrong if we were to conclude that they belonged to a type intermediate between these, which formerly occurred in an area now no longer dry land.

The difference in the colour of different sands depends on the amount and condition of the oxide of iron, forming as it were a superficial varnish. This is easily seen when the grains are mounted in balsam. The quartz itself is the same, and since the state of the oxide might be so soon changed, there is no difficulty in understanding why sands of such very different colours may be associated together.

The green grains of glauconite cannot as a general rule have been derived from pre-existing rocks, and ought rather to be attributed to chemical action occurring either during or soon after deposition, like the minute crystals of gypsum met with in some of the dredgings from the Pacific Ocean.

Clays, &c.—The chief portion of the fine-grained clays cannot be distinguished from the products of the decomposition of felspars and other minerals which can be changed in a similar manner; but mixed with this is a very variable amount of fine sand, in all probability transported in the compound granules already described. Since the sorting of the material depends upon its amount, and on the conditions of the current, there seems reason to hope that a further study of the ultimate character of clays may throw much light on these questions. Some of these indicate that they were rapidly deposited from very muddy, shallow water, and others that they were deposited from much clearer and deeper water.

Volcanic Ash Beds in British Strata.—Extensive masses of rock have been often described as *ash beds*, but, when we come to examine the detailed structure, their true nature becomes very doubtful. Some of them may really have been true ashes, but they have undergone so much subsequent change that they are now totally unlike the ashes of modern volcanoes. The whole question requires much more examination, and the study of the subsequent alterations becomes the principal consideration, and it would lead me into far too wide a field of inquiry to enter upon it now. That true but much altered ashes do exist is, however, clearly shown by some beds found at Bathgate, near Linlithgow. These show a structure which seems to indicate that they were originally a pumice ash, but the vesicles have been filled with infiltered mineral matter, and the whole greatly altered by chemical changes taking place after deposition.

Conclusion.

Leaving then out of consideration such cases, and confining our attention to by far the greater bulk of our British non-calcareous stratified rocks, we see that a most careful microscopical investigation shows that the material was originally derived mainly from the chemical decomposition and mechanical breaking up of various granitic and schistose rocks, the products having been afterwards separated and sorted by the action of currents, and more or less consolidated and changed by subsequent mechanical and chemical action. When we come to study the detail, it is also possible to form a satisfactory conclusion respecting the share which each of the above-named classes of rocks contributed to the formation of each particular stratum, and also to answer several questions of great interest in connection with the geological history of a very important group of stratified rocks, which hitherto have not been supposed capable of yielding any such information. Though these conclusions are

in perfect harmony with well-known geological facts of an entirely independent character, yet some at least could not have been established in a satisfactory manner without tasking the utmost powers of the microscope, which are often required to see and identify the extremely small or larger particles of which the rocks are composed.

EXPLANATION OF PLATE CLXXIV.

FIGS. 1, 2, 3.—Grains of quartz from decomposed granite.
FIG. 4.—Grain of quartz from schist.
FIGS. 5, 6.—Grains showing the contrast between simple and complex structure when seen with polarized light.
FIG. 7.—Fragment of hornblende.
„ 8.—Fragment of felspar.
„ 9.—Fragment of felspar seen with polarized light.
„ 10.—Fragment of decomposed felspar.
„ 11.—Granule of kaolin in various positions, very highly magnified.
„ 12.—Fragment of pumice.
„ 13.—Grain of quartz sand from Millstone Grit.
„ 14.—Fragment of granite from the Millstone Grit.
„ 15.—Grain of sand from the Desert.
„ 16.—Fragment of mica schist from the slate rocks near Moffat.

II.—*Measurements of Rulings on Glass.*

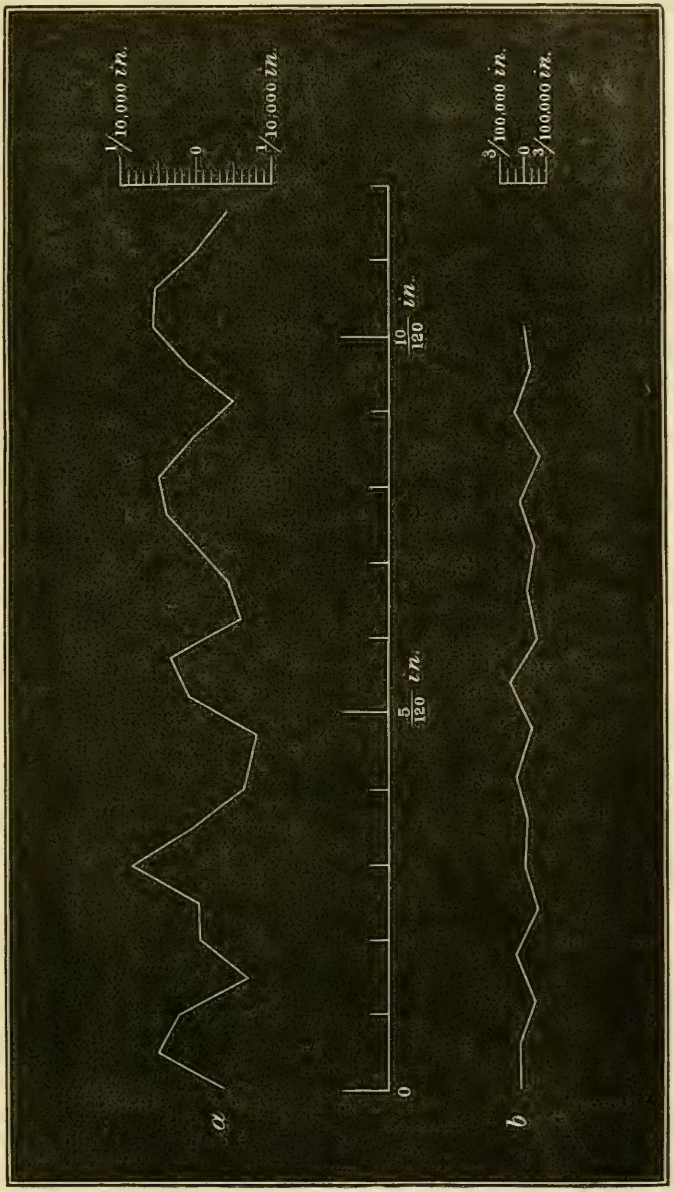
By Edward W. Morley, Western Reserve College, Hudson, Ohio, U.S.A.

Plate CLXXV.

In November 1875, Mr. Rogers, while employed in perfecting the details of his engine for ruling lines on glass, asked me to measure the intervals between the lines on a plate which he ruled for the purpose and sent to me. It contained a hundred heavy lines ruled twenty-four hundred to the inch, forty heavy lines ruled four hundred and eighty to the inch, forty light lines ruled like the last, ten lines ruled twenty-four to the inch, and a hundred light lines ruled twenty-four hundred to the inch. My attention was given to the detecting and measuring any periodic errors occasioned by periodic errors in the screw of the ruling engine, by eccentricity of the screw head, and by other causes producing similar results. To determine this kind of inequality with the smallest probable error, it was obviously proper to measure, not intervals produced by a hundredth of a revolution of the screw, but intervals ten or twenty times as large. Twenty-three intervals of the hundred and twentieth of an inch as nearly consecutive as possible were therefore measured. After several preliminary trials with objectives of foci ranging from two inches to the sixteenth of an inch, a nominal inch objective, whose focal length is really eight-tenths of an inch, was selected for the work. It had been found that the same care with this objective gave results with a less probable error than any other tried. Mr. Rogers afterwards suggested that even a quarter-inch objective was too low a power to afford the required accuracy. While I cannot undertake to say what instrumental appliances are best suited to the habits, methods, and predilections of another observer, the fact remains that for myself the work in hand could be done with this objective so that a given amount of care made the probable error of results less than when the work was done with either a half, quarter, eighth, or sixteenth. The fine adjustment of the stand was screwed hard down and left untouched throughout the measurements. The micrometer employed was a cobweb micrometer by Troughton, having two movable wires. The screw heads have each a hundred divisions; the fourth part of a division was read by estimation. Two readings were taken for each interval measured, between which the screw heads were both moved several divisions. The wires were brought to the edges of the images of the lines of the glass plate, till the minimum visible bright line between the image and the wire was the same for each wire. As each interval was measured only twice, one can hardly compute the

Upper Curve: Abscissæ.	Upper Curve: Ordinates.	Lower Curve: Abscissæ.	Lower Curve: Ordinates.
Millim.	Millim.	Millim.	Millim.
0	− 4·2	0	+ 0·8
5	+ 5·1	6	+ 0·8
10	+ 2·4	12	− 1·2
15	− 6·7	18	+ 1·4
20	− 1·0	24	− 1·4
25	− 0·3	30	+ 0·2
30	+ 8·6	36	− 0·2
35	+ 0·8	42	+ 1·2
40	− 6·1	48	− 0·7
47½	− 7·8	54	+ 2·0
52½	+ 1·3	60	− 1·4
57½	+ 3·6	66	− 0·3
62½	− 5·8	72	− 1·2
67½	− 4·2	78	+ 0·7
76¼	+ 4·1	84	− 1·7
81¼	+ 5·1	90	+ 1·4
86¼	+ 0·5	96	− 0·7
91¼	− 4·7	102	+ 0·2
96¼	+ 1·2		
101¼	+ 5·8		
106¼	+ 5·4		
111¼	+ 0·3		
116¼	− 4·1		

Horizontal scale, 10 millim. = $\frac{1}{120}$ inch.
Vertical scale, 10 millim. = $\frac{1}{10000}$ inch.


1/10,000 in.
0
1/10,000 in.
10/120 in.
5/120 in.
0
3/100,000 in.
0
3/100,000 in.
a
b

probable error of a mean. But the probable difference of the two measurements of one and the same interval will afford a convenient and, for the purpose, sufficient means of estimating the degree of confidence which may be felt in the result. The differences between two measurements of the same interval were one-fourth of a division in seven cases, two-fourths in five cases, three-fourths in three cases, one division in two cases, one division and one-fourth in four cases, and one division and two-fourths in two cases. From this it appears that the probable difference of the two measurements of the same interval is fifty-six hundredths of a division of the screw head. Now the value of one revolution of the screw in the given circumstances was the fourteen hundred and seventy-sixth of an inch, or 0·0006775. Hence the probable difference of two measurements for the same interval was the two hundred and sixty-one thousandth of an inch. It will be seen that this degree of accuracy was amply sufficient for the purpose. It will be noticed that twelve of the actual differences were smaller than the probable difference, and eleven were larger.

In Figure *a*, Plate CLXXV., the measurements are plotted by making the abscissæ proportional to the distance of the initial line of each measurement from the line where the measurements began, while the ordinates are proportional to the differences between the successive measurements and a constant subtrahend. It will be seen that an error whose period is five times the measured interval is clearly indicated.

If the shortest interval of each of these five cycles is subtracted from the longest, the differences are successively seventy, eighty-six, fifty-five, fifty-eight, and fifty-eight: the unit being the four hundredth part of the revolution of the micrometer screw. Half of the mean of these differences is that part of the periodic error which corresponds to the fifth part of the circumference of the screw of the ruling engine, or to an arc of seventy-two degrees. This quantity is eight and seventeen hundredths divisions of the screw head of the micrometer. If this be multiplied by the ratio of the diameter of the circle to the chord of the arc or seventy-two degrees, we have a tolerable approximation to the whole periodic error of those threads of the screw which produced these lines, as the screw was at the time adjusted. This quantity is the ten thousand six hundredth of an inch, or 0·000094 inch. This quantity represents the greatest possible displacement of a line from its true place, as far as the displacement is periodic and not accidental; the greatest possible difference between two professedly equal intervals is double this quantity.

If doubt is felt as to the propriety of assuming that the errors for a fifth of a revolution and for a half revolution are proportional to the chords of the arcs, the total displacement of a line by periodic

error may be computed in another way. If we subtract the mean of the whole twenty-three measurements from the successive measurements, we get the following column of residuals. If now we add all the successive residuals which have the same sign, we get the total measured displacement of the last line before the change of sign. In this way we obtain the column of displacements.

Measured Intervals.	Mean.	Residuals.	Displacements.
12,237	12,299	− 62	
12,375	,,	+ 76	+ 112
12,335	,,	+ 36	
12,200	,,	− 99	
12,285	,,	− 14	− 117
12,295	,,	− 4	
12,425	,,	+ 126	+ 139
12,312	,,	+ 13	
12,210	,,	− 89	− 203
12,185	,,	− 114	
12,320	,,	+ 21	+ 74
12,352	,,	+ 53	
12,215	,,	− 84	− 146
12,237	,,	− 62	
12,360	,,	+ 61	
12,375	,,	+ 76	+ 145
12,307	,,	+ 8	
12,230	,,	− 69	− 69
12,317	,,	+ 18	
12,385	,,	+ 86	+ 191
12,380	,,	+ 81	
12,305	,,	+ 6	
12,240	,,	− 59	− 121

The mean displacement, without regard to sign, is thirteen divisions and two-tenths; this quantity is the eleven thousand two hundredth of an inch, or 0·000089 inch. This quantity is twenty-four times as large as the probable difference of two measurements of the same interval. It is identical with the previous value. This agreement shows that the error is proportional to the chord of the arc of the screw which corresponds to the measured interval. It may be said that since the measured intervals were not all absolutely consecutive, the first method probably is the more accurate.

Mr. Rogers, who did not for a time admit the conclusiveness of the foregoing measurements, thought that the periodicity shown in my results was most probably due to periodicity in the micrometer screw employed. But it is obviously impossible to suppose that to such a cause could be due inequalities amounting to a fifth part of its pitch. And further, the measurements were so made that the effect of periodic errors in the micrometer could per-

ceptibly affect only the accuracy of the reduction of the differences to fractions of an inch, while such errors could not affect the relative magnitudes of these differences except by quantities which may be neglected.

A plate ruled by Mr. Rutherford, of New York, was afterwards measured in the same way, but with less care in making contacts. Eighteen intervals were measured; the differences of the two measurements of the same interval were nothing in two cases, one in five cases, two in three cases, three in three cases, four in one case, seven in one case, and eight in three cases; the unit is the four hundredth of a revolution of the screw head. The probable difference of the two measurements of the same interval is sixty-seven hundredths of a division. If the measurements be plotted, as in the former case, the result is seen in Figure *b*. If the shorter interval in each cycle is subtracted from the longer, half the mean of these remainders is the greatest observed displacement of a line by periodic error. This quantity is the seventy-six thousandth of an inch. This is but four and one-half times as large as the probable difference of the two measures of the same interval. The measurements therefore cannot be used to give the amount of periodic error in Mr. Rutherford's screw, while they conclusively show that it is much smaller than in the former case.—*Read before the American Association for the Advancement of Science, August* 1876.

NEW BOOKS, WITH SHORT NOTICES.

*The Microscope and its Application.**—The appearance of a second edition of Professors Nägeli and Schwendener's Handbook of the Microscope (on the merits of which there is but one opinion abroad) will be hailed with interest by many in this country. Nor will this interest be diminished by the circumstance that the text-books which respectively represent foreign and English micrography differ so widely in subject, plan, and treatment. Our English manuals scarcely enter upon that optical ground which is supposed to be specially reserved for the practical optician, whose authority as the designer and constructor of microscope combinations is accepted without question. On the other hand, they give full play to the fancy which dictates preferences for variety in size, shape, and mechanical arrangement of the instrument; in which respects the only guiding principle of any value—namely, that the instrument should be as little as possible encumbered with mechanical appliances, and that as much as possible should be left to the skilled manipulation of the observer—is too often neglected. But the English manual is chiefly distinguished by its fullness of detailed directions "how to work with the microscope," and naturally blends with these directions a great amount of information regarding the various subjects of microscopic research as well as their technical manipulation. And thus it happens that the most important chapters of the English treatise are *not* those in which the optical construction of the microscope is explained, but rather such as treat of "its revelations."

But in the foreign handbooks, treating professedly of the theory and construction of the microscope, no place is made for disquisitions upon subjects of natural history, histology, or the special sciences of anatomy, pathology, &c. Firstly, because the theory of the microscope is treated in Germany as a physico-mathematical problem, in the demonstration of which the physicist and mathematician have equal if not superior rank with the mechanical constructor. And secondly, because the establishment of various schools of microscopy in the several university towns, and the issue of various scientific journals by professors connected therewith, as well as the frequent publication of special monographs, render every facility for micrographic literature, without trenching upon the volume specially devoted to the theory of the microscope and its manipulation.

In the present phase of microscopic science another motive to study of the optical conditions under which appearances seen through the microscope must be interpreted, comes strongly into play: a motive which ought to be felt equally by all who profess to look a step or two beyond the mere amusement found in observing toy

* 'Das Mikroscop: Theorie und Anwendung desselben,' von Carl Nägeli, Professor in München, und S. Schwendener, Professor in Basel. Zweite verbesserte Auflage, mit 302 Holzschnitten. Leipzig: Verlag von Wilhelm Engelmann. 1877.

objects. For the surprising diversity—not to say antagonism—of view entertained by different observers who have over and over again examined the same object and yet have interpreted so differently the appearances observed, could not but lead to the conclusion that the microscopic image itself is not always the same unaltered transcript of the same light and shadow picture. The more difficult therefore the problem placed before the microscope for solution, the more needful should it seem that the theory of the compound microscope be again strictly revised, if the difficulties of interpretation which increase with every fresh strain put upon the instrument are to be overcome. By Teutonic minds the relegation of so congenial a labour into the hands of the optician was not likely to be tolerated ! and as little would they be content that such knowledge should lie outside the recognized sphere of scientific investigation.

The physico-mathematical investigation of the theory of the microscope has thus naturally fallen into the hands of those for whom this subject possessed special attraction. But it may also be fairly expected that all who are interested in microscopic research generally, should desire to hear of any new discovery that might come to light, or of any fresh aspect in which what was already known might appear after renewed examination. A second edition of a well-accredited work has therefore real significance, and appears opportunely for the lovers of microscopic science at a period when the limit of the powers of the microscope seems to have been reached, and, in default of adequate explanation and rational guidance, a certain misdirection of energy in any further efforts to add to its powers becomes imminent.

The work of Professors Nägeli and Schwendener, of which we here propose to give a short account, brings down to the end of the year 1875 the latest summary of the optical questions connected with the theory of the microscope and of the conditions under which the various objects submitted to microscopic analysis are seen. A glance at the table of contents will best show the German method of handling a rather complicated theme, and the space occupied by each section will roughly indicate the relative importance of each.

Section 1.—103 pages are devoted to the theory of the microscope and the demonstration of optical problems therewith connected.

Section 2.—6 pages containing remarks and recommendations relating to mechanical arrangements, with 15 pages of description and woodcut illustration of foreign stands of various makers.

Section 3.—60 pages occupied with discussion of modes of procedure for testing the accuracy of optical construction and the relative values of lens combinations.

Section 4.—50 pages. The theory of microscopic vision, including the phenomena of "interference"; the effect of illumination upon various objects seen by transmitted light direct and oblique; and the effects produced by objects in motion, and by changes of level (in focussing different planes).

Section 5.—15 pages on the simple microscope.

Section 6.—35 pages on technical manipulation.

Section 7.—62 pages on phenomena of polarization.

Section 8.—104 pages on micro-physics.

Section 9.—62 pages on micro-chemistry.

Section 10.—113 pages on the morphology of vegetable organisms.

The purely technical character of this handbook will be at once inferred from the brief abstract of contents here given. For even in the concluding chapter on vegetable morphology the physico-mathematical method is as equally predominant as in the rest of the work. It is not possible to convey by any condensation or analysis an adequate idea of the profound research and practical knowledge displayed by the authors in their treatment of the several sections; but it may interest our readers if we touch upon a few points which are either new to the majority of English microscopists, or on which the judgment of competent experts, whose opinion derives weight from their special experience, is opposed to the general belief and practice in this country.

1. Binocular microscopes do not find favour in Germany. A stereoscopic arrangement must of course produce the same appearance of solid dimensions of objects which other instruments of the kind effect; but whether, say our authors, any aid is thereby afforded to scientific observation — for example, whether the discrimination of actual differences of form and density is thus facilitated—we must take leave to doubt.

The authors' explanation of the stereoscopic effect, so far as it depends upon physical grounds, is as follows. Each of the two pictures formed by the two halves of the objective shows an altered distribution of light and shadow as compared with the light and shade of the picture ordinarily transmitted through the whole area of the objective, the shadow prevailing on the side of the excluded half area, so that a shift of light and shade in opposite directions in the two pictures is effected. Which of the two sides is presented to the right or left eye depends on the particular arrangement of prisms, but this makes no difference in the causation of the stereoscopic effect.

How far the depth of field (apparent difference of level of different points of the objective image) modifies the stereoscopic effect is again matter of contention; no one doubts that a certain depth exists, but it is certain that its influence in completing the stereoscopic effect is unimportant, and by no means necessary. For just as the superficial photograph impressions on the ordinary stereoscopic slide unite in a picture giving perspective effects, so must the images of the binocular cause an impression of corporeality, even if there were no depth of field. Helmholtz explains* the production of stereoscopic effect by referring to the position of the dispersion circles caused by points in the object lying in front of or behind the focal plane of the objective image: that is to say, that depth of field is an essential condition of stereoscopic effect. But our authors object that, independently of this supposed action of dispersion circles, the pictures formed by the two half areas of the objective are already differentiated by altered distribution of light and shade, and therefore of themselves bring the

* 'Handbook of Phys. Optik.'

stereoscopic effect to pass. And, finally, say our authors, "We must call attention to a fact that seems hitherto to have been overlooked. The idea of projections and depressions may be caused by mere differences of density, which, when an object is examined by transmitted light, must produce exactly the same optical effect. If we suppose a membrane equally thick throughout, but containing in its substance parts of greater and less density, the denser spots will appear in the stereoscopic picture convex, and the less dense spots concave, and so produce an illusory effect on the senses. For this reason we consider it more prudent, under present circumstances, to prosecute scientific researches with the ordinary monocular instrument."

2. We pass on now to another subject of general interest, upon which our authors have expressed a decided opinion, namely, the significance of aperture of objectives.

Referring to the distinction originally made by Herschel in the case of the telescope between defining and penetrating power as one which applies equally to all optical instruments, not excepting the eye itself, our authors say, "Let it not be forgotten that penetrating power rises or falls not with the aperture of the refracting lens, but with the aperture of the cones of light which proceed from the object to the lens. It is self-evident that when incident pencils of light occupy only a part of the aperture of an objective the whole of the unoccupied portion is inactive." When, however, a parallel is drawn (as has been done by Goring and others) between penetrating power as understood in the telescope, and that which is termed penetrating power in the case of the microscope, it becomes necessary to examine in what sense this transference of idea is to be explained. Now in the telescope its entire aperture is occupied by beams of light which come from the object seen (as if they were self-luminous), and an increase of its aperture (just as the widening of the pupil of the eye) has only one purpose, namely, increase of light when the objects to be seen are weakly illuminated. If this light be too strong, wide aperture exercises only a disturbing influence, as lenses of wide aperture are mostly affected with serious aberration. But, say our authors, the illumination can be intensified at will in the case of the microscope (up to application of direct sunlight), so that the need of large aperture for illumination does not come into consideration. Further, it is well known that the cones of light admitted through the diaphragm openings are so small that the rays converging on the focal plane form cones which have not commonly a greater aperture than 23°–30°, and these, after undergoing a change of course in the objective, again group themselves into cones which appear as if they severally came from separate points of the object to form an image of that object in the microscope. The apertures of these pencils are approximatively the same as those of the incident pencils. Supposing therefore an objective to have 60° to 80° of aperture, the separate pencils only partly occupy this aperture, so that the sense in which penetrating power has been used as a term applicable to the telescope (i. e. the power of penetrating space gained by additional admission of light) is altogether misapplied in the microscope. The large object-glass of the telescope

collects light from a distance, but the *resolving* of distant points of light (as double stars) is more dependent upon the freedom of lenses from aberration than upon their size, and thus in the microscope likewise the capacity to "bring out" lines, points, and minute details of structure must be associated with similar resolving power of the telescope, not with its "penetration." *

In seeking to determine the significance of aperture our authors show that the dioptric function of the lens depends just as much upon the aperture of pencils incident from the object (this being itself governed by the size of the openings in the diaphragm or screen which marks the boundary of the illuminating cones) as upon its own aperture, and that it is theoretically unimportant whether with an objective of 60° aperture a diaphragm opening giving 30° aperture of incident pencil is used, or *vice versâ*, so that the advantage of wide-angled aperture does not relate to the image-forming function, except in so far as middle and peripheral zones of a wide-angled lens offer the possibility of a correction of aberrations which shall affect each area separately, and therefore the optician may make the peripheral zone work well with oblique illumination, leaving the central zone less perfect. The authors fully accept Professor Abbe's demonstration, that the value of aperture consists in the admission of the diffraction pencils which arise in objects containing details minute enough to cause diffraction of the illuminating pencils. and that all minute structure can only be transmitted as interference images by pencils which a small-angled objective cannot take in. The following extract contains an expression of opinion respecting this particular item of Professor Abbe's work, which, coming from experts ranking amongst the highest authorities on a subject which they have made their own, is honourable to themselves while giving the place of honour to another.

"It may not be superfluous to note here with emphasis, that up to the present time the precise effect of aperture has not been established as a scientific fact in any work on micrography known to us, much less has it been explained. Nor do we find in the experiments described by Harting (the second edition of whose treatise has but lately appeared) any decisive result beyond the proof that in a given case (experiment with two microscopes) the peripheral zone of the object determined the issue. Indeed, from the time of Goring up to our own day the whole question of aperture and its effect has been altogether devoid of any satisfactory and sound basis. It is the great merit of Abbe that he has filled up the void by his clear and well-grounded exposition."

In concluding this notice of Professors Nägeli and Schwendener's Handbook we must remark that the chapters 3, 4, 7, 8, 9, and 10 are worthy of the closest attention. The last chapter in particular is

* The same conclusion is arrived at by Helmholtz, and the whole subject of delineation of the objective image by pencils of light whose aperture is regulated by diaphragm openings is fully demonstrated in the essay 'On the Optical Capacity of the Microscope,' a translation of which appeared recently in the 'M. M. J.'

specially worthy of study, the exposition of vegetable morphology therein given being such as only the expert botanist, who is at the same time deeply versed in physical science and minute anatomy, could have written. The whole work is a mine whose treasures might occupy many workers in developing.

PROGRESS OF MICROSCOPICAL SCIENCE.

The Structure of Centropyxis.—Professor Leidy, of U.S.A., who has been publishing a series of papers on the structure of Rhizopods and their cogeners before the Academy of Sciences of Philadelphia, gives the following description of this interesting genus:—"Centropyxis is a nearly allied generic form to Arcella, and is so polymorphous that I have been puzzled to define varieties. The test or basis of the test is membranous, and appears not to exhibit the hexagonal structural elements of that of Arcella. The shape is a modification of that of the latter; the mouth and the summit of the dome being eccentric in opposite directions. The dome varies in degree of prominence, and is always convex. The mouth varies in proportionate size, and is more frequently sinuous at the border than completely circular. The test presents all the variations of colour presented by *Arcella vulgaris.* It is frequently provided with from two to five or more hollow, conical spines diverging from the wider border or that most distant from the mouth. Sometimes the test is clean or devoid of all adherent matters and appears homogeneous; mostly, however, it is more or less covered with mineral particles. Sometimes it is as completely covered with quartzose particles as an ordinary Difflugia, and frequently it is loaded with larger stones along the deeper border. In some specimens the test appears to be wholly composed of a single species of diatom shells. I have observed a peculiar point of structure in most tests of Centropyxis, which appears heretofore to have escaped notice. From the sinuous border of the mouth a number of processes extend upward to the dome. These are expanded at the end, and look as if intended to support the roof of the test, though I have not been able to satisfy myself that they actually reach it. Nor have I been able to ascertain whether the number of processes is constant, but they have appeared to me to vary in number from four to seven. They are not visible looking directly into the mouth of the test, but a glimpse of one or two may be detected when the mouth is aslant, as the test is made to turn towards one side. From the usual discoid form of the test it is not easy to retain it in position on edge to conveniently examine the processes, and when the test is observed with adherent sand they cannot be seen at all."

Bathybius come to life again!—This singular, at one time supposed animal organism, and which has since been relegated by Professor Huxley to the mineral world, has been, so to speak, resuscitated by

the American zoologists. A writer says, as regards Bathybius, which is now again attracting notice, more however in clerical than in scientific circles, it may be said that while Professors Wyville Thomson and Huxley have been inclined to doubt whether this is an organism, Dr. Bessels, of the 'Polaris' expedition, discovered in Smith's Sound a form almost exactly like Bathybius, which, however, he judged to be still simpler than Bathybius, and accordingly named Protobathybius. A description and a figure of it are given from drawings and notes furnished by the author in Packard's 'Life Histories of Animals.' Even if Bathybius should prove to be inorganic, we have *Protobathybius Robesonii* left, and several allied forms of simple Monera, such as *Protamœba protogenes*, and others, which are simple drop-like masses of protoplasm, even without a nucleus. All these animals or plants, it matters not which, but most probably the former, are placed by Haeckel in his *Monera*, a division of organisms adopted by Huxley in a recent paper.

A novel form of Epithelioma is described in an article on the subject in the 'Cincinnati Medical News' for December. The writer, Dr. W. C. Dabney, says that there can be no doubt that the great majority of physicians engaged in general practice, who use the microscope at all, look upon the nest-like arrangement of epithelial cells as characteristic of cancer, and generally of the "epithelial" variety, so-called. This is the teaching of those works on pathological histology which are most used in America, and such were the views which he had been led to adopt in consequence, till a few months ago, when, on examination of an ordinary wart removed from the penis, he found a nest of cells, which he could in no way distinguish from those known to occur so commonly in epithelial cancer. The little growth was about the size of a large English pea, and was attached to the prepuce by a broad pedicle. On removing it, and making a section parallel with the little papilla of which it seemed to consist, he found it to be composed of epithelial cells, which had, in most parts of the section, no definite arrangement, but at quite a number of points they were arranged in nests which were composed generally of flattened cells on the outside, with globular ones in the centre, while beyond the limits of these nest-like arrangements the cells were of irregular shape, and had, as previously stated, no definite arrangement. The whole tumour seemed to be composed of cells, and there were no cylinders to be found—it being, in this respect, entirely unlike the generality of epithelial cancers. A careful examination of a number of sections taken from this papillary new formation, and a comparison instituted between them and sections from an epithelial cancer of the lip, has not enabled him to observe any difference in the structure of the "nests" in the two growths; and the chief difference, so far as he could determine, was the absence of the "cylinders" so frequently found in epithelioma.

How the two eyes of a flounder come to the same side.—Mr. Alexander Agassiz has just published a most interesting fact in natural science. He thus describes the process by which the young flounder which first

has its eyes in the ordinary position, comes to have both organs at the same side of the body:—"I captured one day a number of flounders (about an inch in length) closely allied to the Plagusiæ of Steenstrup, the so-called Bascania of Schiödte; they were so perfectly transparent that they seemed the merest film on the bottom of the glass vessel in which they were kept. They were still entirely symmetrical, the eyes well removed from the snout, with a dorsal fin extending almost to the nostril, far in advance of the anterior edge of the orbits of the eyes. They were of course at once set down (from their size) as belonging to a species of flounder in which the eyes probably remained always symmetrical, and I prepared to watch its future development. It was therefore with considerable interest that I noticed, after a few days, that one eye, the right, moved its place somewhat towards the upper part of the body, so that when the young fish was laid on its side, the upper half of the right eye could be plainly seen, through the perfectly transparent body, to project above the left eye. The right eye (as is the case with the eyes of all flounders), being capable of very extensive vertical movements, through an arc of nearly 180°, could thus readily turn to look through the body, above the left eye, and see what was passing on the left side, the right eye being of course useless on its own side as long as the fish lay on its side. I may mention here that this young flounder, until long after the right eye came out on the left side, continued frequently to swim vertically, and that for a considerable length of time. This slight upward tendency of the right eye was continued in connection with a motion of translation towards the anterior part of the head till the eye, when seen through the body from the left side, was entirely clear of the left eye, and was thus placed somewhat in advance and above it, but still entirely in the rear of the base of the dorsal fin extending to the end of the snout. What was my astonishment on the following day, on turning over the young flounder on its left side, to find that the right eye had actually sunk into the tissues of the head, penetrating into the space between the base of the dorsal fin and the frontal bone, to such an extent that the tissues adjoining the orbit had slowly closed over a part of the eye, leaving only a small elliptical opening, smaller than the pupil, through which the right eye could look when the fish was swimming vertically. While the young flounder lay on its side, the right eye was constantly used in looking through the body, and could evidently see extremely well all that took place on the left side. On the following day the eye had pushed its way still farther through, so that a small opening now appeared opposite it, on the left side, through which the right eye could now see directly, the original opening on the right side being almost entirely closed. Soon after, this new opening on the left increased gradually in size, the right eye pushing its way more and more to the surface and finally looking outward on the left side with as much freedom as the eye originally on the left; the opening of the right side having permanently closed. I have thus in one and the same specimen been able to follow the passage of the eye from the right side to the left through the integuments of the head, between the base of the dorsal fin and the frontal

bone." The author adds:—"This observation leads to somewhat different conclusions from those of Steenstrup, who thought he could prove (from an examination of alcoholic specimens) that the eye from the right side passed under the frontal bone. This is evidently not the case here, the eye passing round it, there being only a very slight torsion of the frontal in this young stage. Although at first glance this appears so radically a different method of transfer of the eye from the one described above, yet if the dorsal fin had not extended beyond the posterior edge of the right orbit the process would have been the same, as is readily seen. I hope soon to give full details, with illustrations, of the process of transfer of the eye in its different stages, in a paper I am preparing on the young stages of a few of our bony marine fishes."

The Development of Algæ.—This subject promises to be well considered in the 'Notes Algologiques,' of which the first part has appeared in Paris by MM. Bornet and Thuret. W. G. F. says of it, in 'Silliman's Journal' (December 1876), that "the plates of this fascicule are twenty-five in number, and, in point of execution, are unequalled by any relating to algæ, excepting those which illustrated Thuret's articles on zoospores and antheridia in the 'Annales.' The work is to algology what the 'Carpologia Fungorum Selecta' of the Tulasne Brothers is to fungology. The text is no less rich and complete than the plates. A general description of the reproduction and reproductive organs of different genera precedes the detailed description of the plates, which, in the present fascicule, represent species referred to by Bornet in his 'Deuxième Note sur les Gonidies des Lichens,' or which were collected by Schousboe in Morocco and determined by Thuret. The notes are a masterly exposition of the reproduction in the Nostochineæ and Florideæ, and are so replete with facts that a single reading barely suffices to give a general notion of the contents. Particularly interesting are the description of the reproduction of *Calothrix confervicola*, and the comparative description of the fruit of the different genera included by older writers under Callithamnion. The fertilization of Polyides, similar to Dudresnaya, is referred to, but will probably be figured later. The work of Agardh is an encyclopædia in which one may find the name of any Florideæ more easily perhaps than in any other. The work of Bornet and Thuret has a different object. Determination of names by a somewhat artificial grouping is subordinated to a true knowledge of the relations of algæ through a study of their minute anatomy and development."

The Lymphatics of the Liver.—Dr. W. Stirling says* that Herr A. Budge,† from his injection experiments, draws the following conclusions regarding the perivascular spaces of the liver. A closed system of lymphatics exists in the liver, and is in most intimate relation to the venous blood-vessels. Within the lobules there are simple lymphatic sheaths around the blood-capillaries, which prevent the direct contact of the hepatic cells with the blood, so that any exchange

* 'Medical Record,' December 15. † Ludwig's 'Arbeiten,' Band x.

between these can only take place through the medium of the lymph. Just as the blood-capillaries at the margin of the lobules unite into larger trunks, so the lymph-sheaths pass into lymphatics, which are placed in the walls of the veins, and by means of the interlobular vessels pour their contents upwards into the lymphatics of the diaphragm, and downwards into those of the hilus.

Microscopic Examination of Hospital Walls.—The 'Medical Record' (December 15) says that some interesting facts tending to confirm previous observations by others have recently been communicated to the Société de Biologie, by M. Nepveu, of the Laboratory of La Pitié. A square mètre of the wall of a surgery-ward having been washed after two years, the liquid pressed from the sponge was examined immediately. It was somewhat dark throughout, and contained micrococcus in very great quantity (fifty to sixty in the field of the microscope), some micro-bacteria, a small number of epithelial cells, a few globules of pus, some red blood-corpuscles, and lastly a few irregular dark masses and ovoid bodies of unknown nature. The experiment was made with all necessary precautions; the sponge employed was new, and carefully washed in water that was newly distilled.

Microscopical Researches on the Growth and Change of the Hair.—Professor Von Ebner sent in to the Vienna Academy a paper on the above subject, on the basis of the anatomical facts. Professor Ebner seeks to elucidate as far as possible the mechanical processes of the growth and change of the hair. Especially it is proved that the inner root-sheath is of the utmost importance for the hair formation, and that the same, notwithstanding its being broken through by the hair, continues to grow during the whole hair vegetation, and in the under part of the hair even with greater rapidity than the hair itself. This information leads to important conclusions, of which one may be mentioned, viz. that the doctrines laid down by Götte and Unna are untenable. Respecting the changes of the hair, the writer defends the doctrine of Langer, that the new hairs are formed in the old derma and on the old papilla. The objections to this doctrine are met by the fact which has been up to the present ignored, that the papilla, at the expelling of the hair, most regularly advances in height. The mechanism of this process is circumstantially entered into. During the upward rising the papilla gets smaller, and beneath the same is formed constantly from the outer and middle hair-skin-line a filament which is identical with the hair-stem described by Wertheim. On the same papilla is formed the new hair. The papilla by-and-by gets gradually larger again and advances, whilst the hair-stem disappears.*

Cranial Morphology in the Urodelous Amphibia.—The philosophic anatomy of the skull in these animals has been carefully worked out by Professor W. K. Parker, F.R.S., who lately read a paper on the

* Weekly Reports of the Royal Academy of Vienna, Natural History Section, July 20, 1876.

subject before the Royal Society.* This paper must be read by those interested in the subject, but we may quote the following passages as being of special interest:—"Then, as I am spending my life not to illustrate the cranial morphology of this type or of that, but as digging down to find *one common root*, I have made an incipient attempt at showing what is common to the whole series of the Vertebrates—of the *brain-bearing* Vertebrates at any rate. It is evident that beneath the neural axis, which arises in 'epiblast,' there is a foundation, laid in 'mesoblast,' of the whole animal, from its snout to the end of its tail. This foundation, or rather *root-stock*, is double, and each moiety lies right and left of a truly azygous structure, the *notochord*—a structure which, according to some, arises in the mesoblast also, but which, according to the latest and best observations (namely, those of Mr. Balfour), arises, in the Selachians at least, in the lowest layer, the 'hypoblast.' Whether the notochord is mesoblastic or hypoblastic, at present is not of vital moment to the morphology of a vertebrated animal: the important points are that the notochord is *universal*, and that it always passes some distance into the skull. There are several important modifications in the region of the *head*, as compared with the body generally, that make the problem of cranial morphology an extremely difficult one. To mention some, there are: (1) the swelling of the neural axis into three vesicles; (2) the flexure of the head upon itself; (3) the development of three pairs of sense-capsules, that press upon its sides and mingle with its structures; (4) the union of a palatal diverticulum with the brain to form the pituitary body, thus arresting the median notochord; and (5) the dying out of the pleuro-peritoneal space in the region of the throat. Thus the modifying causes are manifold in the head of a vertebrated animal,—some of them showing their effects very early in the life of the embryo; whilst others, that relate to the specializations of the parts of the cranium and of the parts of the face, the parts that encircle the mouth and sense-capsules and that form the basket-work of the branchial apparatus—these appear later."

The Embryonic Membranes in Plants.—Professor Famintzin has published a valuable paper on this subject in the 'Botanische Zeitung,' which is thus abstracted in the 'Academy' (December 30):—"The main purpose of the paper is to furnish the proofs of his theory of the development of the initial layers, or embryonic membranes, in plants. Hanstein had previously pointed out the existence of three distinct layers in the developing embryo of *Capsella bursa-pastoris*, and several Compositæ. The further development of these 'three systems of tissues,' Famintzin asserts, has proved to be perfectly identical with the formation of the embryonic membranes in animals. While the embryo is still quite small, and before there is any trace of the cotyledons, the plerome forms an axile cylindrical cord, sheathed in two layers of cells, the periblem and the dermatogen. Soon divisions appear in the dermatogen at the lower end of the

* 'Proceedings of the Royal Society,' vol. xxv. No. 175.

embryo (near the suspensor), and the periblem increases to several layers on the sides of the embryo, but remains one-layered at both ends. As Hanstein has already shown, the root-cap and the primary bark are the result of these cell-divisions. Taking a more fully developed embryo in which the cotyledons are present as two symmetrical projections, and rendering it transparent by Hanstein's method, three membranes or layers of tissue are as clearly distinguishable in the cotyledons as in the axile portion of the embryo; they appear as outgrowths of the corresponding tissues of the axis of the embryo, and subsequently undergo the same changes. Briefly, says Famintzin, the principal results of my investigations may be thus expressed. 'In the earliest stages of the formation of the vegetable embryo three morphologically distinct layers of tissue appear, which during the complete development of the embryo, and most likely during the whole life of the plant, retain, with few rare exceptions (the embryonic vesicle, for instance), their independence, and only certain defined tissues are formed from them. In other words, they correspond exactly to the embryonic membranes of the animal kingdom.' "

Structure and Function of the Leaves of Dionæa.—Two botanists have been lately engaged in studying these subjects, and their researches have been made perfectly independently of each other—M. Casimir de Candolle, in the 'Archives des Sciences Physiques et Naturelles,' April 1876, and Dr. Fraustadt, in the first part of the second volume of Cohn's 'Beiträge.' As might be expected, in regard to the anatomy of the leaves they are in almost perfect accord, but in other respects their conclusions are somewhat different. De Candolle's experiments extended over a period of only six weeks, and, in addition to the question of nutrition, he investigated the mechanism of the leaves. Briefly, his conclusions are these. Animal substances absorbed by the leaves are not directly utilized by the plant, nor necessary to its development. The marginal teeth and edge of the blade of the leaf form a member (organ) distinct from the rest of the leaf, which explains the reason why their movement is not simultaneous with that of the valves of the blade. The stellate hairs and the glands are epidermal structures, whereas the excitable hairs on the surface of the valves are outgrowths of the fundamental tissue beneath the epidermis. The anatomical structure, as well as the development of the different parts of the leaf, favours the hypothesis that the movements of the two valves of the leaf depend upon variations in the turgescence of the parenchyma of the upper surface only of the leaf. According to both observers, no stomates are present on the upper surface of the leaf. Dr. Fraustadt's investigations were of a somewhat different character. Without entering into them in detail, we may give the results of his experiments bearing upon the question of nutrition. The cells of the leaves of Dionæa exhibit, in many respects, an unusual behaviour towards chemical reagents, which seems to point to the presence of a peculiar substance, the nature of which, however, nobody has yet succeeded in making out. Apparently it exists in the living cells in acid solution; consequently it is precipitated by bases and redissolved by acids. Ammonia colours

the red glands on the upper surface of the lamina greenish, and precipitates, in the cells containing starch, a fine-grained substance. And if the ammonia is neutralized by acetic acid the red colour of the glands is re-established, and the granules in the cells are dissolved and disappear. Adding potassium again removes the colour and causes the starch-granules to swell up and become transparent. Finally, the green granules are again precipitated. After carefully washing out the potassium, and then treating the tissue with iodine (as iodide of potassium), the cells are uniformly coloured blue or violet. Dr. Fraustadt also found that the cells of those leaves which had caught little animals, or had been fed with albumen, contained no starch, or very much less than those which had access to no organic food, after these substances had been enclosed a few days. When dyed albumen was presented to the plant, the colour was absorbed even into the vascular bundle of the midrib.

On the Eyes of Worms.— A paper of some interest is that of M. J. Chatin, which was presented to the French Academy (December 18) by M. Milne Edwards. In a previous paper — of which we have given an abstract—the author described pretty fully the minute structure of the *bâtonnets* of crustacea. In the present paper he indicates a series of analogies between the eyes of the annelids and those of crustacea. The eyes of worms present three distinct types: (1) In *Torrea* the eye is extremely perfect, and comprises all the parts that one sees in the eye of Vertebrates. (2) In the various *Serpulæ* the eye is formed by one or more refractive parts placed in a generally elongated matrix. (3) In the *Polyophthalmiæ* the organ consists of one or more analogous pieces, but they are surrounded by a pigmentary mass whose limits are undecided. Now M. Chatin finds that the second group, that of the *Serpulæ*, presents a marked resemblance between its eyes and those of crustacea. Some genera, as, for instance, *Psygmobranchus*, show the analogy very distinctly. Their eyes are, in fact, formed by a piece in which it is easy to recognize two parts: one *superior*, refractive, corresponding to the crystalline lens of authors; the other inferior, elongated, coloured reddish orange (*P. protensus*), and thinning out toward its initial end. If now we compare this with the arrangement in certain of the lower crustacea (*Epimeria*), we easily recognize the complete analogy between the crystalline lens and the cone, and between the *bâtonnet* properly so called, and the lower part brilliantly decorated as above. The author gives several other instances which support his views.

Examination of the Air.—The French Government has set about a thorough examination of the air of Paris by the Meteorological Department. This investigation began on the 1st of January, 1877; and it is described by M. Marié-Davy, in the 'Comptes Rendus,'* somewhat in advance. He states that the reason of this was to seek out if he could discover the cause of an epidemic which has raged for some time in their various barracks. Especially was this the case in the barrack of Prince Eugene, which the War Department at last evacuated. On

* December 27, 1876.

examining the water in this place, it was found quite pure. But on scraping the floor and walls, and placing the dust in the water, a myriad of moving octrios were seen under the microscope. The product in this way obtained from room No. 400 smelt very badly, and by microscopic examination numerous algæ were found, especially *Coccochloris Brébissonii*, and also vibrious bacteria and monads. After twelve hours there were numerous *Amœbæ* found. He thinks that these several bodies have had much to do with the unhealthiness of the locality. However, more observations will be required ere this idea is established.

Development of the Heart in the Chicken.—M. Dareste, who is well known in France for his researches in development, has recently presented a paper on the above subject to the Academy.* It is to form part of a work on development, which he is about to publish, but which will not be out for six or eight months. After describing the results obtained on this subject by Hensen, Kölliker, and Jusser, the author passes on to his own results. And he shows very clearly, by a series of arguments which we must refer the reader to the paper itself for, that in the development of the heart the two ventricles are at first completely separated one from the other. Indeed in an abnormal case he found the two ventricles did not contract simultaneously, but one twice as fast as the other. This is wonderful, for unless the contents of the two cavities differed we do not see how the circulation could have been carried on. We may observe that the separation of the ventricles is a permanent affair in the case of the Sirenia.

Researches on Filaria hœmatica have been recently made by MM. Galeb and Pourquier on this subject, and have been published before the French Academy.† These, however, have done little that has not been already done by Dr. Cunningham, of India, whose work our readers are familiar with. The French authors found Filariæ in the blood of a fœtus of a bitch whose heart was filled with these organisms, but they do not explain how they traversed the double walls of the placenta in order to pass from parent to offspring. Of course we do not imagine that these worms were spontaneously developed, but it is as yet unexplained how they passed through the placental walls.

A New Nematoid Worm has been found by Dr. Normand in the bodies of those who have suffered from diarrhœa in Cochin China.

Tape-worms in Rabbits.—Some short time since a letter appeared in 'Nature,' from Mr. G. J. Romanes, to the effect that, in dissecting some wild rabbits, he found the intestine full of tape-worms. This, of course, was an extraordinary fact, for the rabbit is purely an herbivorous animal. How, then, could the tape-worm have passed through its cystic stage? The difficulty is now removed by a letter to 'Nature' (February 15) from Mr. R. D. Turner, in which he says: "I would suggest that the tape-worm referred to by Mr. G. J. Romanes

* 'Comptes Rendus,' December 27, 1876. † February 5, 1877.

is like the Bothriocephalus of man—perhaps a species of the same genus. This is not supposed to have a cystic state, but to be developed from a ciliated embryo taken into the system on raw or badly-cooked vegetables, which have been watered by sewage from cesspools, in which the eggs will remain alive for months. In the same way the eggs of the rabbit's tape-worm probably remain in the animal's droppings till set free in rain as ciliated embryos. As the rabbit feeds on the vegetation watered by such rain, there is no difficulty in understanding how the embryos would reach his alimentary canal."

Some of the 'Challenger's' Diatoms.—In the 'Annals of Natural History' for February there is an important paper on "The Type of Foraminiferal Structure," in which the author, Dr. G. C. Wallich, points out, among other important items, the circumstance that certain of the so-called diatoms found by the 'Challenger' expedition are not diatoms at all. He says:—"In the report of the 'Challenger' expedition, published in the 'Proceedings of the Royal Society,' 1876, vol. xxiv. pl. 21, there are three figures which are described as representing '*true diatoms*,' to which the generic name of *Pyrocystis* has been given by the discoverers. I am, indeed, grievously mistaken if these structures bear the slightest affinity to diatoms, or are anything else than true oceanic *Noctilucæ.* It would be just as irrational to separate the testaceous from the naked Rhizopods, because the former have hard coverings and the latter have none, as to regard these new forms as distinct from *Noctiluca*, because they present a delicate siliceous wall. The figures of the elongate form, if accurate representations, as they doubtless are, show at a glance that the structure is *not* that of any diatom."

Gigantic Thread-cells.—In a paper read before the Linnean Society, February 15, Mr. H. N. Moseley described the thread-cells of some Actinozoa found by the 'Challenger' expedition, which, he said, were the longest existing forms, being as long as 5 or 6 millimeters, if we remember rightly.

The Tyndall and Bastian Controversy.—Dr. Tyndall recently delivered a Friday evening lecture before the Royal Institution, in which we think, contrary to the views held by the 'Lancet,' February 17, that he once more proved his case. Dr. Tyndall had been unlucky in many of his last year's experiments, and this he clearly showed to be due to the atmosphere of the Institution being laden with germs from a quantity of hay which was virtually "teeming" with them. He then went to Kew, where there is now one of the finest laboratories in the kingdom, and there all his experiments were perfectly successful. In every case but one the specimens showed no trace of life. In that one the experiment broke down and life was very freely developed. But why was this? simply because there was a small aperture like a pin-hole in the side of the test-tube. A perusal of Dr. Roberts's and Dr. Tyndall's paper, in the last number of the 'Proceedings of the Royal Society' (No. 176), will show the reader that the 'Lancet's' view of the matter is hardly a justifiable one.

Microscopical Contents of Foreign Journals.

Zeitschrift für Anatomie und Entwickelungsgeschichte, von W. His und W. Braune, Band 2, 3rd and 4th Heft. Leipzig, 1876.—A good paper is that on the Architecture of Bone Tissue, illustrated by a plate, by Dr. Karl Schulin. In this the author tries to show how the bone structure between the Haversian canals is arranged. He supposes a certain plan which would give the greatest amount of power of resistance to the bones, and he endeavours to show that this is carried out in the structure of certain bones, especially of the skull.—A paper on "The Aqueductus Vestibuli of Man and of Phyllodactylus Europæus," by Professor Dr. Rüdinger, of Munich, is for the most part purely anatomical in the coarser sense of the word. Still the author refers to the microscopical characters of the lining epithelium, so that it deserves mention.—A very valuable contribution is that by Herr G. Schwalbe, "On the Structure of Elastic Connective Tissue," illustrated by a beautifully delineated plate. This paper deals exhaustively with the subject, extending as it does to nearly forty pages. The chief fact of importance is that relating to some of the fibres, which it would seem have a peculiar structure, which appears to endow them with elasticity. There seems to be a division of the fibre transversely into a series of particles, with lens-shaped spaces between them, and it is possibly in this way that their elasticity is provided.—The Structure of the Hair-glands (sebaceous) and their Muscles is a good paper by Herr Dr. F. Hesse, Prosector at Leipzig. This is of interest simply from the fact that the author describes minutely (from a magnifying power of 600 diameters) the structure of the peculiar muscles which are connected with the hair-sac. He dwells at some length on the researches, published in 1875, of W. Stirling.—On Bone Lymph Canals is a brief note by Dr. A. Budge, of Greifswald.

Archives de Zoologie Expérimentale. Edited by H. de Lacaze-Duthiers, Année 1876, No. 2.—This number contains a series of valuable papers:—"On the Development of Mollusks," second paper, by M. H. Fol, deals with the Heteropoda; "On a Species of Infusoria Parasitic on Fresh-water Fishes," by M. Fouquet; and "On the Organs of Sense in the Actiniæ," by M. Korotneff, which is illustrated by a splendid series of drawings, which we commend to Dr. Duncan's notice. The notes and reviews are also of microscopical interest, more especially that on the development of Holathuriadæ, which is by M. E. Selenka.

NOTES AND MEMORANDA.

Microscopical Vision.—In the present aspect of this important question, which is being inquired into by Abbe, Sorby, and others, the following remarks are of interest. They are made by the President of the Dunkirk Microscopical Society (U.S.A.), Mr. G. E. Blackham, in a letter—part of which is private—to the Editor. He says, speaking of one of the reports of his Society:—"I am well aware that some of the work done by Professor Smith at this meeting will not meet with ready credence, especially among those who have on *a priori* grounds set the limit of microscopical vision at 80,000 lines to the inch; the facts are, however, just as stated in the report, and I may say that, in the quiet of my own parlour, Professor Smith showed me the lines of the 19th band on one of Nobert's recent 19th-band plates, clearly resolved, with my own 'duplex' $\frac{1}{6}$th objective, 'A'—2-inch—eye-piece, on Zentmayer's army hospital stand, fitted with thin revolving stage—the illumination being lamp—bull's-eye and concave mirror, without achromatic condenser, or other light modifier whatever."

Dr. J. E. Smith on Wenham's Reflex Illuminator.—This American microscopist gives an opinion of Wenham's illuminator as follows:—"My first attempt with the illuminator in the histological line was over a balsam slide of pavement epithelium from my own mouth. The first field, as given by the illuminator, reminded me of a painting depicting the Arctic regions in a gale of wind! I saw scores of icebergs projecting their long black shadows over the field in inextricable confusion—any attempt to correct the objective at that stage of my experience would have been folly. I was very far from being discouraged, for it was palpable that the very power that caused the havoc in my field, would, when properly harnessed into the traces, do yeoman service. Removing the illuminator, I selected the smallest nucleated scale, and one which was far distant from the larger organisms, bringing it to the centre of the field and clamping the object carrier. Again, trying the effect of the illuminator, the result was similar to that of the initiatory trial. But now, knowing the exact locality of the scale beyond a doubt, I soon managed to identify it, and, after correcting the objective, was rewarded by a display of *surface markings* that amply repaid all costs. The details of this and similar investigations with the Wenham illuminator I hope before long to submit. Those who use the illuminator have noticed the ease with which blue, red, green, and the intermediate tints are obtained in the field. Some ten days ago it occurred to me to try unmodified sunlight with the instrument, presuming that the *blue* field due to the reflex might have the same effect as the intervening pane of blue glass which I had before used and recommended in the 'News.' The experiment was a perfect success, and I saw No. 20 of the Möller plate, not exactly as coarse 'as the pickets on a fence,' but more like the teeth of a fine-toothed comb. The $\frac{1}{4}$th inch solid eye-

piece was used and amplified, still I had oceans of spare light, nor was the definition of the objective at all taxed. These results, it seems to me, are valuable, in that we can now get rid of the cupro-ammonia cell, and of the blue glass: neither of these could be successfully used receiving the solar beam through a closed window. With the Wenham illuminator I could discover no sensible difference in the definition, whether the window was open or closed. This alone, in the winter season, will be a great boon to the microscopist." *

Cleaning Diatoms with Glycerine.—The 'American Naturalist' (February 1877) says that Mr. James Neil, of Cleveland, uses glycerine as an easy and efficacious means of separating diatom shells from the foreign matter with which they are naturally mixed. He fills a 2-ounce graduated measuring glass three-quarters full of glycerine and water mixed in equal parts. The diatoms, after being treated with acid and thoroughly washed, are then shaken up in some pure water and poured gently over the diluted glycerine. If carefully done the water and diatoms do not at first sink into the glycerine, but gradually the diatoms sink through the water, and into the glycerine, preceding the light flocculent matter held in the water. After a few minutes, a pipe introduced closed through the water and into the glycerine will bring up remarkably clean diatoms, which are to be afterward freed from glycerine by repeated washing and decanting.

Eosin: a New Staining Fluid.—Dr. Dreschfeld states in the 'Journal of Anatomy' (vol. xi. part 2) that a solution of eosin, of 1 part to 1000 of water, forms an admirable staining fluid. The sections to be stained, having been immersed in this fluid for one minute to a minute and a half, are put for a very short time into water slightly acidulated with acetic acid, and can then be mounted in glycerine or in Canada balsam. The advantages claimed for this fluid by the author are these:—1. The time required for perfect staining does not exceed one to one and a half minute. 2. The solution can be kept without altering, and remains perfectly clear for any length of time. 3. Eosin has the property (probably owing to its fluorescence) of clearing tissues. 4. It differentiates the component parts of a tissue, which renders it particularly applicable to complicated structures, as tumours. Dr. Dreschfeld finds it particularly useful in the examination of nervous tissue. The nuclei, nucleoli, and processes of the ganglion-cells, and the axis-cylinder of nerve-fibres, are stained light pink; the areolar tissue takes a much deeper colour; the medulla of the nerve-fibres, on the other hand, is not stained at all.

* See 'Cincinnati Medical News,' January 1877.

CORRESPONDENCE.

Mr. Bramhall on the Bramhall Illuminator.

To the Editor of the 'Monthly Microscopical Journal.'

St. John's Vicarage, *near* Lynn, *February* 2, 1877.

Sir,—Allow me to say, in answer to the concluding paragraph of Dr. Ward's letter on Mr. Van der Weyde's claim to the invention, which goes by the name of the Bramhall Oblique Illuminator, that, so far as I am concerned, it is original, as I had never heard of Mr. Van der Weyde, or of that other American microscopist who claims to have used the same form more than ten years ago. I believe I may say the same on behalf of Mr. Kitton.

I am, Sir, yours faithfully,

John Bramhall.

PROCEEDINGS OF SOCIETIES.

Royal Microscopical Society.

King's College, *February* 7, 1877.

Anniversary Meeting.—H. C. Sorby, Esq., F.R.S., President, in the chair.

The minutes of the preceding meeting were read and confirmed.

A list of donations to the Society since the last meeting was read by the Secretary, and the thanks of the meeting were voted to the donors.

Mr. Charles Brooke said that, in accordance with notice given at the last meeting, and in order that the printed list might stand good for election, it would be necessary to suspend one of the bye-laws; and he, therefore, rose to move that Bye-law No. 27, Section 6, be suspended on that occasion, so far as related to the words "that no person shall fill the office of President for more than two years in succession," in order to enable the Fellows, if they thought fit, to elect H. C. Sorby, Esq., to the office of President for a second term.

Dr. Millar had much pleasure in seconding the motion.

Mr. Charles Brooke having put the resolution to the meeting, it was declared to be unanimously carried.

Mr. J. W. Stephenson, Treasurer, read the Annual Statement of Accounts, which had been duly audited and certified as correct.

Mr. H. J. Slack, Hon. Sec., then read the Annual Report of the Council.

Dr. W. J. Gray moved "That the Reports now read be received and adopted, and that they be printed and circulated in the usual way."

Mr. Frank Crisp seconded the adoption of the Reports.

The President having put the motion to the meeting, declared it to be carried unanimously.

On the motion of Mr. J. W. Stephenson, seconded by Mr. Thomas Palmer, Mr. J. Spencer and Mr. T. C. White were appointed Scrutineers, and the ballot for the election of Officers and Council for the ensuing year was proceeded with. At its conclusion the following gentlemen were declared to be unanimously elected:

As *President*—Mr. H. C. Sorby, F.R.S.

As *Vice-Presidents*—Dr. Lionel S. Beale, Sir John Lubbock, Rev. W. H. Dallinger, and Mr. Hugh Powell.

As *Treasurer*—Mr. J. W. Stephenson.

As *Hon. Secretaries*—Mr. H. J. Slack and Mr. Charles Stewart.

As *Council*—Messrs. W. A. Bevington, Dr. Braithwaite, Charles Brooke, Frank Crisp, J. E. Ingpen, E. W. Jones, W. T. Loy, Dr. Henry Lawson, S. J. McIntire, Dr. Millar, Thomas Palmer, and F. H. Ward.

The President, rising to deliver the Annual Address, took the opportunity of thanking the Fellows for the honour which they had conferred upon him by again electing him President of the Society, especially as his election on that occasion required a suspension of the bye-laws to enable it to take place. He hoped to be able properly to fulfil the duties of the office, and that he should be able to do, during the next year, even more than he had done in the previous one. After reference to those Fellows of the Society deceased during the past year, the President gave a *résumé* of his Address, upon the investigations which he had recently made into the nature and components of the loose materials forming the sands and clays, as well as some sandstones and stratified rocks of Great Britain. The subject was illustrated by drawings upon the board. (The Address will be found printed *in extenso* at p. 113.)

Mr. Charles Brooke rose to propose a vote of thanks to the President for the very able Address to which they had just listened. He was sure they must all feel that a line of inquiry had been pointed out which was altogether new, and which was also one which must certainly lead to some very important results. He had much pleasure in asking that the Address might be printed and circulated in the usual way.

The vote of thanks was then seconded by Dr. Millar, and, having been put to the meeting by the proposer, was carried by acclamation.

The President expressed his thanks for the kind way in which the vote of thanks had been proposed and received. He did not see why a Microscopical Society should not deal with all subjects which the microscope could throw light upon. Some persons might perhaps look upon the subject which had occupied their attention that evening as one suited only for a Geological Society, but he begged to differ from that opinion, and to say that he thought the subject was one which came strictly within their province, and he believed that, not only in the field of geological research, but in others also, there was a great deal to be done by means of the microscope, and

which therefore came fully within their scope as a Microscopical Society.

The President announced that, at their next meeting, a paper by the Rev. W. H. Dallinger would be read, entitled "Additional Note on the Identity of *Navicula crassinervis*, *N. rhomboides*, and *Frustulia Saxonica*."

Annual Report of the Royal Microscopical Society.

February 7, 1877.

John Ware Stephenson in Account with the Royal Microscopical Society.

Dr. | *Cr.*

1876.	£	*s.*	*d.*	1876.	£	*s.*	*d.*
To Balance brought from 31st Dec. 1875	247	2	9	By Cash paid for Journal	240	0	0
„ Half-year's Dividend on 1102*l.* 13*s.* 4*d.* Consols	16	8	7	„ Rent and Attendance at King's College ..	57	1	9
„ Ditto on 1124*l.* 18*s.* 11*d.*	16	13	11	„ Reporter	12	12	0
„ Composition Subscription	42	0	0	„ Mr. Reeves' Salary ..	80	0	0
„ Annual Subscriptions, &c.	418	2	0	„ Commission	11	16	0
„ Journals sold	1	10	0	„ Ray Society for 1876 ..	1	1	0
				„ Fire Insurance	1	4	0
				„ Stationery and Printing	15	18	9
				„ Books	7	11	9
				„ Petty Cash	35	0	0
				„ Soirée Expenses	9	14	6
				„ Cash paid for 22*l.* 5*s.* 7*d.* Consols	21	0	0
				„ Book Shelves	5	15	0
				„ Slate and Stand	2	12	6
				„ Instruments and Repairs	8	19	0
				„ Stamped Cheque-book	0	4	2
				„ Balance remaining 31st Dec. 1876	231	6	10
	£741	17	3		£741	17	3

Jan. 29, 1877. Examined and found correct,

CHARLES JAMES FOX.
F. W. GAY.

Library, Apparatus, and Collections.

The additions made to the library, apparatus, &c., since the last Report are given below.

The Council had much pleasure in responding to the request made by the Government for aid to the Loan Collection at South Kensington, and sent thereto a selection of instruments of historical interest.

The books and collections are in as satisfactory a condition as the limited space and means at the disposal of the Society have permitted.

The following are the more important works presented during the year:

Transactions of the Linnean Society.
Transactions of the Royal Irish Academy.
The Application of Photography to Micrometry, with special reference to the Micrometry of Blood in Criminal Cases. Illustrated with Photographs. By Dr. J. J. Woodward.
Medical and Surgical History of the War of the Rebellion, Part 2. From the Surgeon-General, U.S.A.
Quinology of the East Indian Plantations. By John E. Howard.
Mémoire sur les Caractères Mineralogiques et Stratigraphiques, &c. Par MM. Poussin et A. Rénard.
Six sets of Photographs, with Pamphlets. By Dr. J. J. Woodward.

Books Purchased.

Quarterly Journal of Microscopical Science.
Annals of Natural History.
Proceedings of the Royal Society.
Mycographia Icones Fungorum. Parts 2 and 3.

Apparatus, Slides, &c., Presented.

Three Slides of Minerals, from F. Rutley, Esq.
Four Sections of Coal Fossils, from Mr. Norman.
Three Slides of Diatoms, from Mr. F. Kitton.

Papers read before the Society during the past Session.

Optical, Instrumental, and Technical.

"On the Characters of Spherical and Chromatic Aberration arising from Excentrical Refraction, and their Relations to Chromatic Dispersion," by Dr. Royston-Pigott.

"On a New Arrangement for Illuminating and Centering with High Powers," by Rev. W. H. Dallinger, March 1st, 1876.

"Measurements of Möller's Diatomaceen-Probe-Platten," by E. W. Morley, March 1st, 1876.

"A New Microscopic Slide," by E. V. Broeck, April 5th, 1876.

"On a New Form of Pocket Spectroscope," by H. C. Sorby.

"A Stage Incubator," by H. A. Reeves, December 6th, 1876.

"Notes on Micro-photography," by Surgeon-Major Gayer, May 3rd, 1876.

"On a New Process of Preparing and Staining Fresh Brain for Microscopical Examination," by Bevan Lewis.

"Observation on Professor Abbe's Experiments illustrating his Theory of Microscopic Vision," by J. W. Stephenson, January 3rd, 1877.

"Observations upon Mr. William Rogers' Paper on a Possible Explanation of the Method employed by Nobert in Ruling his Test-Plates," by W. Webb.

"On the Present Limits of Vision," by Dr. Royston-Pigott, October 4th, 1876.

"On a New Method of Measuring and Recording the Bands of the Spectrum," by Thomas Palmer, B.Sc., October 4th, 1876.

"On the Measurements of the Angle of Aperture of Object-glasses," by F. H. Wenham, November 1st, 1876.

Natural History and Mineralogy.

"The Identification of Liquid Carbonic Acid in Mineral Cavities," by W. N. Hartley, F.C.S., March 1st, 1876.

"On some Structures in Obsidian, Perlite, and Leucite," by Frank Rutley, F.G.S., March 1st, 1876.

"Note on the Markings of Navicula rhomboides," by Dr. J. J. Woodward, April 5th, 1876.

"Some Results of a Microscopical Study of the Belgian Plutonic Rocks," by A. Rénard, S.J., April 5th, 1876.

"On the Markings of the Body-scale of the English Gnat and the American Mosquito," by Dr. J. J. Woodward, May 3rd, 1876.

"On Remulina Sorbyana," by J. F. Blake, May 3rd, 1876.

"On the Rotifer Conochilus volvox," by Henry Davis, June 7th, 1876.

"On the Microscopical Structure of Amber," by H. C. Sorby and P. J. Butler, October 4th, 1876.

"A Curious Fact in connection with certain Cells in the Leaves of Hypericum Androsæmum," by W. Hinds, M.D.

"Experiments with a Sterile Putrescible Fluid exposed alternately to an Optically Pure Atmosphere," &c., &c., by Rev. W. H. Dallinger, November 1st, 1876.

"Bastian and Pasteur on Spontaneous Generation" (translation), by H. J. Slack.

"The Markings of Frustulia Saxonica," by Samuel Wells.

"On Navicula crassinervis, Frustulia Saxonica, and Navicula rhomboides, as Test-Objects," by Rev. W. H. Dallinger, December 6th, 1876.

"On the Relations between the Development, Reproduction, and Markings of the Diatomaceæ," by Dr. G. C. Wallich, January 3rd, 1877.

Twelve gentlemen have been elected Fellows, and two have been elected Honorary Fellows of the Society during the year, and the Society have to regret the loss of seven ordinary and one Honorary Fellow.

Obituary.

Christian Gottfreid Ehrenberg was born on the 19th of April, 1795, at Delitzsch, in Saxony, of which town his father was what we may perhaps call "town regent" (Stadtrichter). Even at the early age of fifteen he evinced a strong taste for the study of natural history; but being destined by his father for the Church, he was sent to study theology at the University of Leipzig. He, however, soon resolved to devote himself to a profession more closely connected with his favourite subject, and applied himself to the study of medicine, thinking it impossible to earn his living by devotion to pure science. In 1819 he commenced practice, but abandoned it in the course of a

year, and fairly commenced a career of scientific research, which was continued uninterruptedly for more than half a century. His early papers were chiefly on botanical subjects, and his first great discovery, made in 1820, was that fungi are developed from spores, and not by spontaneous generation. The minute anatomy of animal tissues also attracted his attention, but his fame chiefly rests on the many brilliant discoveries which he made in connection with living and fossil Foraminifera, Polycistinæ, and Infusoria, using this term in the sense employed by him, which included many organisms now regarded as plants.

The earliest paper connected with these subjects was published in 1829, and from that date until 1875 there appeared a constant succession of valuable papers, or separate works, relating to minute animal or vegetable forms. His last was on marine and fresh-water dredgings from all countries, published in 1875, when eighty years of age.

At the commencement of Ehrenberg's splendid researches the achromatic microscope was quite in its infancy; and, if we may rely on the conclusions to be drawn from a careful examination of the older microscopes in the late Loan Collection at South Kensington, something like one-half of Ehrenberg's work must have been done with microscopes which nowadays would be looked upon as scarcely good enough for toys, much less for research. When we reflect on what he did with such imperfect instruments, and what many of our present microscopists do with their splendid apparatus, one cannot but feel that the eye at one end of the tube is, after all, the most important part of the whole optical arrangement. We all know very well that Ehrenberg was led into many errors, but, considering the means at his command and the extreme novelty and difficulty of some of his investigations, we may be surprised more by the truths discovered than by the mistakes made.

What strikes us most is the vast extent and continuance of Ehrenberg's researches. Independent of his great works on the Infusoria, on Microscopic Geology, and other kindred subjects, the number of separate memoirs published between 1820 and 1873 was no less than 293; being, therefore, an average of five or six, continued over a period of no less than fifty-three years. We must forbear to notice in detail even a mere fraction of these publications. We can scarcely over-estimate the effect of all this work on the advancement of microscopical science. Perhaps one of the most important conclusions was that minute organisms have contributed very much to the formation of thick masses of stratified rocks, and that such deposits as our chalk are—or, perhaps, still more correctly, were originally—most closely similar to deposits now being formed in modern oceans. He was elected an Honorary Fellow of our Society in 1840, and died on June 27, 1876, at the age of eighty-one years.

Edward Newman, F.L.S., &c., was born at Hampstead, on May 13, 1801. At a very early age he evinced a taste for natural history, which was fostered and encouraged by both his father and mother. After his school days were passed he resided with his father at

Godalming, carrying on the business of a wool-stapler, but all the while devoting himself to the study of his favourite subject. In 1826 he removed to Deptford, where he engaged in the business of a rope manufacturer. It is said that in his garden there he specially cultivated such flowers as attract many insects, and devoted much time to the study of their habits. He was one of the original members of the Entomological Club; and when this club started the 'Entomological Magazine,' he was chosen to be its first editor; and for upwards of forty years the collection of the club was under his personal care. Towards the end of 1840 he became connected with a publishing firm, and conducted the business until 1870, during which interval were brought out several valuable works on insects and ferns, to the study of which plants he had devoted much attention. Amongst other publications may be mentioned the 'Zoologist,' of which no less than thirty-three annual volumes were published under Mr. Newman's supervision.

In 1858 he became the natural history editor of the 'Field,' and continued to fill that post until his death. Amongst his papers in this periodical may be specially named those on economic entomology, being perhaps the first to point out to agriculturists the true way to deal with their insect enemies. Mention may also be made of his two valuable works on British Moths and British Butterflies, which latter was written by him when in his seventieth year. He died on the 12th of June, 1876, at the age of seventy-five, having by his many separate works and very numerous original memoirs, and by means of the Journals published under his editorship, largely contributed to advance and disseminate a knowledge of various important branches of natural history. He was elected a Fellow of our Society in 1840.

Though Dr. Francis Sibson, F.R.S., was elected a Fellow of the Microscopical Society in 1853, his scientific investigations were only indirectly connected with microscopical research, and had more special reference to general human anatomy and to the practical application of remedial measures. He was born in 1815, near Maryport, in Cumberland, and received his medical education in Edinburgh and London. For thirteen years he was resident surgeon to the Nottingham Hospital, after which he removed to London. The subjects to which he directed his attention were chiefly more or less closely connected with the physiology and pathology of respiration; but he was also the author of a valuable work on medical anatomy. He died suddenly at Geneva, on the 7th of September, 1876, aged about sixty, from the bursting of an aneurism, when almost in the act of telegraphing to say when he would arrive at his residence in London.

William Delferier, born December 23, 1800, died July 15, 1876. Joined the Microscopical Society in 1847. For more than twenty-five years he was an enthusiastic worker with the microscope, and interested himself in its optical and mechanical improvement. He acquired great skill in the display of difficult objects and in testing glasses, and when Messrs. Powell and Lealand contemplated the improvements carried out in their first-class microscope, he entered

warmly into their plans, and the first instrument of the new pattern was made for him.

John Newton Tomkins, born 1812, died 1876. Joined the Society in 1857. He studied surgery under Joseph Henry Green, and passed with distinction through the medical curriculum of St. Thomas's Hospital. He was for many years Inspector of the National Vaccine Institution, and was a Fellow of the Royal College of Surgeons, and of the Royal Botanical and Zoological Societies. He formed an extensive collection of microscopes, apparatus, and objects, and for many years promoted microscopical pursuits by scientific gatherings at his house in Fitzroy Street, which afforded opportunities for examining novelties and for friendly discussion.

The Secretaries have not been able to obtain any biographical information concerning the following:

Chas. Gilbertson, elected Feb. 13, 1861, died Dec. 10, 1876.
Henry Hopley White, elected April 1841, died Dec. 10, 1876.
Andrew Yeates, elected March 1854, died Feb. 16, 1876.

Donations to the Library since January 3, 1877:

	From
Nature. Weekly	*The Editor.*
Athenæum. Weekly	*Ditto.*
Society of Arts Journal	*Society.*
Annuaire de L'Observatoire de Montsouris pour L'An 1877.	
Memoir of the Life and Works of Edward Newman. By his Son ..	*Author.*
Bulletin de la Société Botanique de France, 1876	*Society.*
Annales de la Société Belge de Microscopie, 1875–6	*Ditto.*
Bulletin des Seances de la Société Belge de Microscopie, 1874–5 ..	*Ditto.*
Transactions of the Linnean Society. Two parts	*Ditto.*
Set of Photographs	*Dr. Oliver, Chicago.*
Popular Science Review. No. 1. New Series	*Publisher.*

Dr. John Habirshaw, and Frederick Habirshaw, Esq., of New York, were elected Fellows of the Society.

Walter W. Reeves,
Assist.-Secretary.

Medical Microscopical Society.

Annual General Meeting, January 19, 1877. Dr. J. F. Payne, President, in the chair.

This was the first meeting held in the new rooms of the Society, 6, Pall Mall Place, W.; and the additional comforts and advantages offered over the old room seemed to be fully appreciated by those present.

The Secretary's Report for the year 1876 was read.

The following are the names of the communications read before the Society during the past year:—President's Address, Dr. Payne. Development of New Blood-vessels, Dr. Thin. Browning's Triplet Mr. Jabez Hogg. Modification of Pritchard's Microtome, Mr. Giles. Hints on the Systematic Study of Histology, Dr. Woodman. Cirrhosis of Liver in Child, Mr. Needham. Freezing Microtome, Mr. R.

Williams. Microscope for Viewing Circulation in the Frænum Linguæ, Dr. U. Pritchard. Carcinonia of Liver simulating Cirrhosis, Dr. Goodhart. Myeloid Sarcoma, Mr. Needham. Organ of Corti in Mammals, Dr. U. Pritchard. Rodent Ulcer, Mr. Golding-Bird.

The soirée of the Society was held on June 30. Of the fifty-four microscopes exhibited, twenty-four were devoted to a series of typical tumours; besides these, a variety of instruments and photographs was shown.

The number of members of the Society in December 1876 was 129.

Several presents during the past year both of books and specimens were received; and upwards of seventy different preparations besides apparatus were exhibited at the close of the meetings, in the same period.

The Treasurer's Report showed on December 31, 1876, a balance of 30*l.* 9*s.* 3*d.* against one of 20*l.* 9*s.* at the same time in the previous year. The soirée expenses amounted to 19*l.* The actual increase in the income of the Society was therefore nearly 30*l.*

The retiring President then delivered his address.

He congratulated the Society upon its numbering 122 paying members, and thought that just at this time it might be said to be passing through a crisis; it had outgrown its developmental stage, and now hoped for something better. Originally designed to be of service to medical students, it soon found its sphere of action among those far senior to students; and he would say that in his opinion this Society offered a more congenial field for the investigation of histological pathology than any other in London.

One function he deemed specially belonging to the Society, i.e. to study the influence of histology—normal or pathological—in every-day medical practice; this included a very large but very important field if we include its relation to hygiene.

A clearer knowledge of tissues had helped us to understand more of pathological conditions; gave also a clearer precision in diagnosis, and sometimes even a general hint as to prognosis and treatment. Such a subject as "degeneration," how different was its aspect now to that of the prehistological period! Fatty infiltration was now easily distinguished from "fatty degeneration," while the practical bearing of this was found in the recognition now of sudden death from a fatty heart—a condition proved by histological investigation, and even admitted sound in courts of law. Again, with regard to tumours, what numbers of varieties were classed under the one head malignant or even cancer, now known to be perfectly distinct from each other, and how usual was it to appeal to the microscope ere the surgeon gave an opinion as to the recurrence of the disease.

Several other instances of the use rendered to practice by the microscope were quoted, particular stress being laid upon the help it had been in elucidating the intricacies of Bright's disease. Chorea was brought forward as showing what yet remained to be done, for till its histological pathology were determined, who could say that it was not the expression of several diseases?

In conclusion, the President remarked that this anatomical knowledge was after all but the beginning of medicine. Still it was an improvement upon the time when the physician walked on air, so to speak—having nothing but symptoms to guide him—and given an anatomical basis, it would for most diseases at least be a histological one. The difficulties of investigation were great, and the slowness of discovery was not the fault but the misfortune of the histologist.

Liverpool Microscopical Society.

The ninth ordinary meeting of this Society was held at the Royal Institution, Friday, December 1, the Rev. H. H. Higgins, A.M., in the chair.

Captain Jno. H. Mortimer, of the U.S. ship 'Hamilton Fish,' an associate member of the Society, exhibited a number of marine specimens which he had presented to the Free Public Museum. He also communicated some interesting facts in connection with the *Physalia pelagica*, known as the Portuguese man-of-war, the tentacles of which are of great length, consisting of a muscular band studded on its margin by rows of beads, each bead being a mass of small spherical cells, each of which contains a small spiral stinging thread, coiled up inside. Portions of the tentacles had been mounted for microscopic examination, and under a power of 500 diameters the cells and spiral contents were easily seen. Captain Mortimer stated that he had frequently witnessed the discharge of the stinging threads from the cells, and that the stinging power was perceptible some days after the death of the animal. He believed that the above facts were new to science.

The paper for the evening was on "Lines of Animal Life," by the Rev. H. H. Higgins. The paper was illustrated by diagrams, especially by one of large size representing a *Stammbaum des Thierreichs*, or genealogical tree of animals, enlarged from 'Grundriss der Zoologie,' by Professor G. v. Koch, published in part, during the present year.

A short and interesting discussion followed, after which the meeting concluded with the usual conversazione.

San Francisco Microscopical Society.

A meeting of the San Francisco Microscopical Society was held December 21.

Mr. Isaac Lea donated to the cabinet a sheet of Phlogopite Mica from Canada, and another of Muscovite Mica from Chester County, Pennsylvania. Mr. Lea also exhibited a new micaceous mineral known as Hallite, a film of which he placed on the stage of the microscope and called attention to its characteristics.

Mr. Hanks presented a sample of diatomaceous earth from a newly discovered deposit in Ione Valley, Amador County, California.

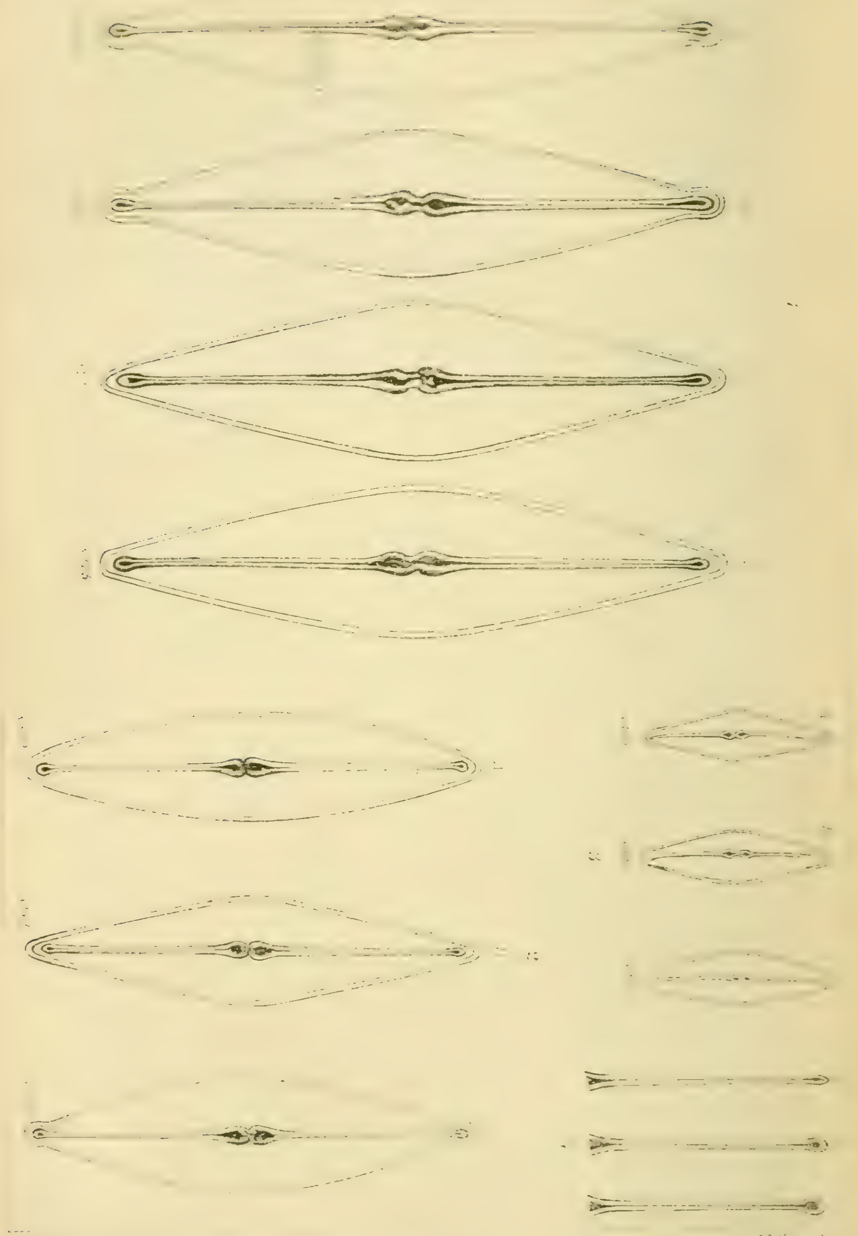
A small portion hastily prepared showed several forms, mostly *Diatoma* and *Navicula*.

Four slides, being sections made in different directions of a hard deposit showing woody structure, found in the body of the Mount Diablo coal vein, and termed "Nigger Head" by the miners, were donated by Mr. S. B. Christy. On examination, the wood fibres were clearly shown, and their general appearance was that of the oak.

Mr. Hanks handed in a report on a sample of (so-called) silver mud from Oregon.

Mr. Kinne exhibited several slides of diatoms mounted by Professor H. L. Smith, of Hobart College, Geneva, New York, which had been received in the way of exchange, and called the especial attention of the members to the preparations of Professor Smith and his authentic series of diatoms.

Mr. J. P. Moore handed in a new fungus, which he described at length, and has named *Lentinus aurantius*.



Hunger del. ad nat.

... the frustules of ...onica and ... Crassinervis

THE

MONTHLY MICROSCOPICAL JOURNAL.

APRIL 1, 1877.

I.—*Additional Note on the Identity of Navicula crassinervis, Frustulia Saxonica, and N. rhomboides.*

By Rev. W. H. Dallinger, V.P.R.M.S.

(*Read before the* Royal Microscopical Society, *March* 7, 1877.)

Plate CLXXVI.

It would have been a matter of much interest to me to have been present at the discussion which followed upon the reading of my paper upon the above subject in December last. I might have been able to afford or to evoke explanation that would have served to further elucidate the subject.

The only report of the discussion I have access to is that given in the January number of the 'M. M. J.,' which doubtless is substantially correct. In the interests of science, and with a simple desire to elicit truth, I may be permitted the privilege of this note upon some of the statements it contains.

And first, of course my paper did not aim at *proving*, or, on my own authority, even asserting, the *identity* of the diatoms in question. I simply *accepted* this on the authority of Professor H. L. Smith and Mr. Kitton, which to myself was, and still is, perfectly competent. But accepting the identity of these forms thus established, I sought to augment its value by a fact—in itself of some optical interest—that all these forms were in ultimate structure precisely alike; so that, using the lowest power that would reveal the beaded arrangement on the surface of the smallest forms, we could, by using successively larger forms, with the same power, see precisely the same arrangement with increasing clearness and ease.

DESCRIPTION OF PLATE CLXXVI.

Fig. 1, A, B, C, D.—Four forms of *N. rhomboides* in a gathering from "Cherryfield," showing modifications of outline, with the existence of the links uniting the two extremes (A and D). β in A shows that the striation was that belonging to *N. rhomboides*.

Fig. 2.—Similar examples from specimens taken in the living state at Llyn-cum-Bychan.

Fig. 3.—Similar evidences of change of form in the smaller frustules known as *N. crassinervis*.

Fig. 4.—Different modifications occurring in the apexes A, B, C, of the mid-ribs of these diatoms.

Now the report of the discussion affirms that "Mr. Ingpen suggested that, after all, the question of *genus and species* depended upon *difference in shape,* and not upon the absolute number or fineness of the lines." * From which I should gather that the identity of ultimate structure which I pointed out, taken together with the opinion of the authorities named, had left the speaker unconvinced of the identity of the forms in question; since there were palpable though minute differences of shape in the drawings submitted. Now I have not the slightest desire to defend or seek to sustain the identity. This is in far better hands; and the facts I presented remain the same, whether the three forms be identical or not. But the position taken by Mr. Ingpen involves a biological question of large importance. Every possessor of a microscope knows that if there be one thing that is permanent in *Navicula* and *Pleurosigma,* it is not necessarily the tenuity or coarseness of the striation, but its *arrangement;* and it was to this that I specially called attention in the forms in question. On the other hand, I am prepared amply to prove that the "*shape*" of these diatoms is subject to almost infinite variation: small in any given case, doubtless, but occurring in every conceivable direction. Nor am I alone in this affirmation. I number amongst my friends and acquaintances many amateur, and several professional, mounters of diatoms; through whose hands, and under whose eyes, millions of certain forms pass every year; and without a single exception they assure me that between any two contrasted and comparatively unlike forms of the "same species" they can find almost every intermediate grade or link.

Now the point in question is, are we to establish a species upon a *variable* or an *invariable* characteristic? Is specific identification to depend upon that which is always changing in indefinite ways, or upon that which practically never changes?

My first *great* lesson in biology was learned, incidentally, many years ago, from Professor W. K. Parker, who dispelled for ever my hard-and-fast view of species in Foraminifera by showing me every conceivable link between two species. The meaning of it never left me; and supplied by him with a rich store of foraminiferal material from almost every part of the world, I quietly worked over hundreds of thousands of forms; and, so far as the mere shell was concerned, proved to myself clearly that many so-called species were merely extreme modifications of the "species" to their right or left, and that every intermediate modification could be found; a truth which has had ample illustration from Professor Rupert Jones in our recent 'Transactions.' †

But years of study have convinced me further, that this mutability is not confined to this group of the Protozoa. It is

* 'M. M. J.' January 1, 1877, pp. 52, 53. † 'M. M. J.' vol. xv. 61.

everywhere manifest, where from their extreme minuteness and multitude, large numbers of microscopic organisms can be constantly compared.

It is pre-eminently true, for example, of the desmids and the diatoms. Of course I need not remark that the mere study of *mounted* specimens is utterly incompetent for proof in such an investigation. One might as well attempt to generalize upon the osteological characteristics of a given skeleton by the observation of a limited number of specimens seen through the glass fronts of museum cases. It can only be done, as the Fellows of this Society well know, by the careful examination of unmounted material in every variety of condition.

I have already said that my knowledge of the Diatomaceæ does not extend much beyond the silicious frustules; whilst I have spent comparatively little time in endeavouring to accomplish difficult feats with test-objects. But a working microscopist must have a set of crucial standards, thoroughly known to himself, to serve for comparison; and *N. rhomboides* in its several varieties was very early adopted as mine: hence I have had an interest in this frustule which has extended over years; and especially since the prominence given to "*F. Saxonica*" and "*N. crassinervis*" I have examined very large quantities of material derived from both England and America. It is my habit to make a drawing of *any* fact of moment in any of my observations; and I invariably do this in relation to variations of form in any well-known object or objects. Since reading the rule given by Mr. Ingpen, on which the determination of genera and species is said to depend, I have turned over the leaves of my folio, and have found some singularly suitable cases of *variation* in the "shape" of *N. rhomboides* (of course including *F. Sax.* and *N. crass.*), which are of considerable service; all the more indeed that some of them have been drawn for years, and all were drawn in entire independence of the question in hand.

In Fig. 1, Plate CLXXVI., are the outlines of four frustules taken from a gathering of "Cherryfield" rhomboides. They were of course drawn at different times, and from different "dips" of the material, and are doubtless not commonly to be found; but whoever is supplied with sufficient material and patience might, I am convinced, select and arrange frustules precisely in the order in which they stand in the Plate. Apart then from the general symmetry, if the *ends* of the frustules drawn be examined, it will be seen that between A and D there is a remarkable difference; but if B and C be inserted in order between them, we have comparatively easy steps from the one to the other.

Now the only diatom that I know of that in *all* respects comes near to A and B is *Navicula cuspidata;* but (1) as a rule the

apexes of the frustules of this form have no *constrictions* as seen in A and B, and *never*, so far as my knowledge goes, a constriction so *great* as in A; and (2) although the striation is, in a general sense, the same as in *N. rhomboides*, anyone thoroughly familiar with both could never mistake the one for the other; and to show that the character of the beading is distinctively that of *rhomboides*, a portion has been carefully drawn at β, A, Fig. 1. This was done with a magnification of 450 diams., and reduced; while the same nature and arrangement precisely of hemispheres or beads were demonstrated in each of the other three forms in Fig. 1.

The point is, if "shape" be the characteristic on which the determination of "genus and species" depends, then surely A, B, C, and D are each of them separate species! Moreover, at times it happens that the two ends of a given frustule are not absolutely like *each other*. In Plate CLXV., belonging to my paper published in the last Journal,* it will be seen that in Fig. C the right end of the frustule is not like the left one. This is strictly true to nature. A constriction is found at one end and not at the other; does this make it, and similar forms, specifically different? It was stated in the discussion that the drawing of the large specimen which I had sent to the Society had not the "rhomboidal outline"; but if I had considered that "outline" of the slightest moment, it would have been an easy matter to find one that had. Do I rightly understand that such a specimen, if found and presented, would have to be considered a distinct species from the one drawn; and which one of the speakers (Mr. Ingpen) declared "he should hardly call a rhomboides at all"? If this be true, I can only say that there is, in what is now known as *N. rhomboides*, plenty of work for those who desire to engage in the labour of describing and naming species.

But it appears to me that this canon for determining the generic and specific differences of diatoms cannot hold good. It certainly must be rejected by the biologist. The differences between A and D, Fig. 1, are not greater than those seen in many of the varieties of several species of fern; nay, they certainly are not greater than the difference existing between a bulldog and a greyhound, or between a "pouter" and a rock-pigeon. And I think that we should therefore have no right to consider them specifically different, even *if* the intermediate links could *not* be found; which they certainly can.

But whilst we have all this variation in *form*, there is one characteristic that is practically unchangeable; it is the *character* of the "striation." It is perfectly true that, although it is the *rule* that the smallest frustules have the most delicate striation, it is not (so far as my experience goes) invariably so. Small frustules

* The present paper was sent to the Secretary in January, but could not be read until March, the Presidential Address intervening.

may have *relatively* coarse striation. But the *arrangement of the hemispheres* is, in frustules of *all* sizes, unalterably the same.

Now as we do not select the *variable* but the *invariable* characteristics of the dog to define it specifically, on what principle should we ignore an *invariable* characteristic of *N. rhomboides* (and all other Naviculæ), and attempt to determine it specifically upon characteristics which are found, when large numbers are examined, to be constant only in their variability?

That this variation is ever recurring, I may further illustrate.

I have lately been examining a fine gathering of *N. rhomboides* from Llyn-cum-Bychan, North Wales. The frustules are very large, and the beading or striation comparatively coarse. They were taken in the living state, and only cleaned for examination, and not for mounting. Fig. 2, A, B, C, gives the outlines of forms of frustules found repeatedly. I need not point out the varieties of form or "shape" which they present; they are sufficiently obvious. But I may remark that in all the "striation" was identical. Now I would ask, do these varieties of "shape" constitute *specific* differences? or rather, are they held to do so? Because, if they are, we should have a distinct and scientific method for their detection.

Again. In an examination of a good-sized pocket-collecting bottle full of "material," in a well-cleaned state, of smaller forms, such as have been called *F. Saxonica* and *N. crassinervis*, I have detected and drawn the forms seen in Fig. 3, A, B, C, no less than five times, quite independently of each other; but the striation was alike in all.

Finally, the "nodules" were commented on as exhibiting variety, in my drawings; and this was taken as, apparently, important, and the form of the nodule combined with the "shape" of the whole frustule was suggested as the basis of *specific* demarkation. I can only say that it would have been by no means impossible to have selected "nodules," in every case, *alike;* and however unlike any two frustules may be, it would be possible to find the intermediate links. In Fig. 4 are the midribs of three forms, occurring in the Llyn-cum-Bychan and "Cherryfield" gatherings not infrequently; and the same are also to be found in "Lancashire" and "Bennis Lake" cleaned material. These special varieties were drawn from the Llyn-cum-Bychan specimens, and it will be seen that B is simply a *link* between the extremes A and C. And whilst it is not invariably so, I find a tendency towards the association, in the frustules, of such a nodule as C, Fig. 4, and such a termination or apex as A, Fig. 1; whilst a midrib terminating as in A, Fig. 4, is associated with such an apex as C, Fig. 1. This tendency is (quite accidentally) depicted in the drawings sent with my last paper, and still preserved in the Plates.

So far am I from seeing the need of multiplying species on

what, in the light of the facts I submit, appear mistaken grounds, that I am the rather inclined to see how *very* many of them might be shown to glide insensibly into each other, having *no* rigid line between. But *this* of course would not be enough, unless the developmental history in all the said cases were coincident or nearly approximate—a matter on which I cannot speak. But when, on good authority, three Naviculæ, called separately by specific names, are affirmed to be capable of being considered one species, so far as their life-history is concerned; and when it is further shown that the "striation"—a permanent feature—is the same in each; in consideration of the fact that both the "shape" of the outline of the frustule and the form of the "nodules" are constantly subject to minute variations, it appears to be a case, fairly made out, of specific identity. This, however, is, comparatively speaking, a side issue; the great point is, whether it is *possible* to make what are shown to be the variable features of a diatom—taken in entire independence of its life-history—the elements for determining its species?

There are three things in most Naviculæ that vary: (1) the general outline of the frustule, (2) the midrib as a whole (although, so far as my examination goes, it is much less variable than the outline of the frustule), and (3) the *tenuity* of the beading or striation. There is one thing (*broadly speaking*) which is invariable—it is the character or *arrangement* of the beading.*

* I write thus guardedly because I am convinced, as I have already hinted, that with a complete knowledge of the life-histories of all the forms of the Naviculeæ there might be an immense reduction of what are now known as specific forms. Take, for example, such a prominent form as *N. granulata* and compare with it *N. latissima*, *N. humerosa*, and *N. brevis* on one side, and *N. marina*, *N. pusilla*, and *N. carassius* on the other side, and I suspect that complete search would find all the intermediate forms. In like manner there can be but little question that in either old or living forms the intermediate steps between *N. rhomboides* and *N. cuspidata* might, although perhaps with difficulty, be found.

The transition forms between *Pleurosigma fasciola* and *P. macrum* and *P. prolongatum* are almost at hand without searching; and I imagine that many of us who have examined a large number of slides or "material" of the forms *P. angulatum*, *P. quadratum*, and *P. elongatum* have often wondered at what point the one ceased and the other began. Of course if their life-histories are essentially different from each other, then their remarkable similarity and blending into each other must be regarded merely as coincidence, or in some sense "mimicry." But if their developmental histories only differ enough to account for their differences of form, then I think such forms extremely instructive and well worthy the careful study of those who seek for direct and living proof of developmental changes in existing organisms: a matter much more readily discovered in minute forms, seen together in enormous numbers, and subject to critical investigation in their entirety, than in the larger and more complex organisms, which, when taken in the greatest numbers in which they can be found, for critical examination, are but, relatively, few indeed.

In fact, therefore, in saying that even the *arrangement of the beading* in the diatoms, chiefly discussed in the above "Note," is permanent, I merely mean that it is so relatively to the other parts; but in all probability this permanence is only, in reality, an indefinite persistence, a feature, that is to say, immensely *less liable* to change or vary than others.

II.—*The Exhibitor: a Novel Apparatus for showing Diatoms, &c.*

By the Hon. and Rev. the Lord S. G. Osborne, B.A., F.R.M.S.

Will you kindly permit me to introduce to your readers a little addition to the apparatus of a microscope, which I am sure will well repay its cost, and the little practice in its manipulation, required for its perfect success.

In nearly thirty years' enjoyment of the microscope—using it for many hours on the greater proportion of my days, applying it to all kinds of investigation—I always coveted some simple means of getting a good oblique light for illuminating, under the higher powers. I have bought and borrowed a good many ingenious inventions for the purpose, and have generally succeeded in getting fair results, but always with more trouble than was quite agreeable, to say nothing of the expensive nature of the means used.

After a great deal of experiment, and much hard work, with very indifferent tools, I am at last quite satisfied. I have for the last few months had more enjoyment from the microscope than I ever had before, and this from a very simple contrivance. The Diatomaceæ I had observed under other modern inventions, but until now I never saw their real beauty, or got such satisfactory information as to their construction.

I will now give the plainest description I can of "the Exhibitor." I take a "Darker" stage, as used for polarizing. I have two counter-sinkings made on its stage front in the revolving ring; one, *the top one*, rather larger in circumference and shallower than the lower one. Into the lower "sinking" I drop a disk of blackened metal with a small kettledrum lens mounted in the centre. Into the upper "sinking" I place metal disks with certain apertures made in them; the front of these disks is just level with the face of the stage, the back close to the front of the disk holding the small lens.

I have a fine screw-worm cut into the back part of the revolving ring, coming up just below the lower counter-sinking. Into this screws a ring of brass carrying a bull's-eye or kettledrum lens, of about the diameter of a shilling. The screw movement having a milled edge, it can thus be focussed as required with the small upper one.

It will be at once seen that the Exhibitor is thus nothing more complex than a Darker stage with two kettledrums, the larger receiving the light from the lamp, transmitting it to the small one, which latter then delivers it at the back of the metal disk which is flush with the front of the stage, the screw movement enabling the observer to focus the two drums.

As to the apertures to be cut in the metal disks, after a great

deal of study I have arrived at the conclusion four such apertures will meet all that can be desired. No. 1, a fine "slit," in length about the diameter of the upper "drum," *in the centre.* No. 2, a similar aperture, a little way, say not quite its own length, from the centre. Nos. 3 and 4, a pin-hole and triangle, also a little out of the centre; these may all be cut in one disk.

On the stage I have two steel springs for holding the slides, giving the means of shifting them in any direction.

Now for the *modus operandi.* Having screwed the lower drum home to the extent of the screw, drop in the disk with small drum (I have three of different diameters and projection); on this place the aperture disk; place and cramp the Darker on the stage; turn the mirror, and place the lamp so as to get the aperture *lighted up, but not with the brightness as with direct illumination;* put on a slide, say of Angulatum (I prefer those of "Möller"); adjust the mirror until you get a rather red appearance on the slide at the side farthest from the lamp. Focus down on this: when you come on *a bright clear light,* like that obtained from ordinary sub-stage illumination, by moving the stage laterally you will arrive at a portion of the slide with darker and darker background as you continue to move it. It will now depend upon manipulation of the mirror to bring the object on this ground to its best definition. A little practice soon makes this easy. Supposing you have got an "Angulatum" well shown—i. e. on dark ground—clear and *crisp;* turn the milled head of the Darker stage and you will thus intensify or moderate the light. Having found with any one aperture good definition of any one object in a slide, with your fingers you can bring any specimen in the slide over this spot. I have thus brought every single object in the Typen-Platte of Möller successively in view, developing their respective beauty in a way I had hardly thought possible.

I rarely use a mirror, infinitely preferring the Abraham's achromatic prism adjusted to the mirror bar; I can by my hand so alter the direction and amount of light with this, I desire nothing better.

I use the ordinary Bockett lamp and condenser, *with a small flame* edgeways to the prism.

I have worked of late chiefly with a $\frac{1}{14}$th of Zeiss, which I find quite capable of resolving almost every test on which I have tried it: it brings out both sets of lines on the Rhomboides, showing where they intersect. A $\frac{1}{4}$ inch of Andrew Ross also gives me wonderful definition. The $\frac{1}{2}$ and 1 inch of the same maker, with binocular, the objects on pitch-black ground, bring out many with a distinctness I have failed to get any other way.

I prefer objects mounted dry, but seldom fail with any; as a proof of the way I now get definition; having dissected and mounted the gizzards of the Rotifers, I thought I knew their

mechanism well; I now find I had never before seen a row of teeth, shown clearly under the Exhibitor. I use it now for white-light illumination; indeed, I scarcely use any other illuminator.

It requires practice and patience to master its manipulation, but well repays it.

I have placed my models in the hands of Mr. Baker, of High Holborn, Mr. Curties having been here to see me work the instrument, and having lent me great assistance in getting lenses, &c., made for me. He has fitted one for me exactly as described above, and I find it perfect in use. I have no doubt but he will have them constructed at a moderate price, and show their use to anyone who may apply to him.

I shall be more than satisfied if any of our Fellows get a tenth part of the pleasure I have had in the use of this little affair. That it may be capable of improvement I can conceive, and shall be most glad if it is so improved by those who are more scientific than myself.

SIDMOUTH.

III.—*On the Phytoptus of the Vine* (*Phytoptus vitis*, Landois).*

By Professor GIOVANNI BRIOSI, of Palermo.†

PLATES CLXXVII. AND CLXXVIII.

MARCELLO MALPIGHI has been the first to investigate scientifically this evil, which attacks many other plants besides the vine.

This disease consists in a kind of protuberance which is formed on the leaves, which in consequence assume a characteristic speckled aspect.

These protuberances, galls, or cecidii,‡ have, for the most part, a roundish or oblong, sometimes an irregular form, especially when through spreading they run one into another, assuming in consequence various sizes, so that leaves are found (at least at Favara)

* Translated from the Italian by W. R.

† Professor Targioni Tozzetti proposes for this disease the name of *Erinosy* (it was he at least who did, I believe), but to me the name of *Phytoptosy* seems more appropriate from the moment that it has been proved not to be due to a fungus (*Erineum*), as it was once thought, but to a mite (*acarus*), the *Phytoptus*.

‡ As the word *gall* could probably be only applied to pathological products of more or less roundish form, Thomas, to whom we are indebted for most accurate researches about this disease, proposed ultimately to designate by the Greek word *cecidium every abnormal formation* (*in which the plant takes part*) *of the plants, caused by parasites;* hence *diptera-cecidium*, *acaro-cecidium*, *myco-cecidium*, &c., according to whether the galls are due to *diptera*, *acari*, or *fungi*, &c. Besides grouping in two large categories all these varieties, viz. those caused by attacks of parasites with negative cones, and those due to attacks in other parts of the plants, he called the first *acrocecidii* and the second *pleurocecidii*, and lastly *cecidozoids* the animals, *cecidophyti* the plants producing parasitism. Beiträge z. Kennt. d. Milbg. n. d. Gallm. in Giebel's Zeitsch. f. d. gesammten Naturwissenschaften, vol. xlii. p. 517.

which, thus attacked, have not a single spot left healthy and uncovered.

Convex on the upper and concave on the under side of the leaves, these parasites present themselves covered with minute hairs, whitish in spring, later on reddish, or of a more or less dark tobacco colour.

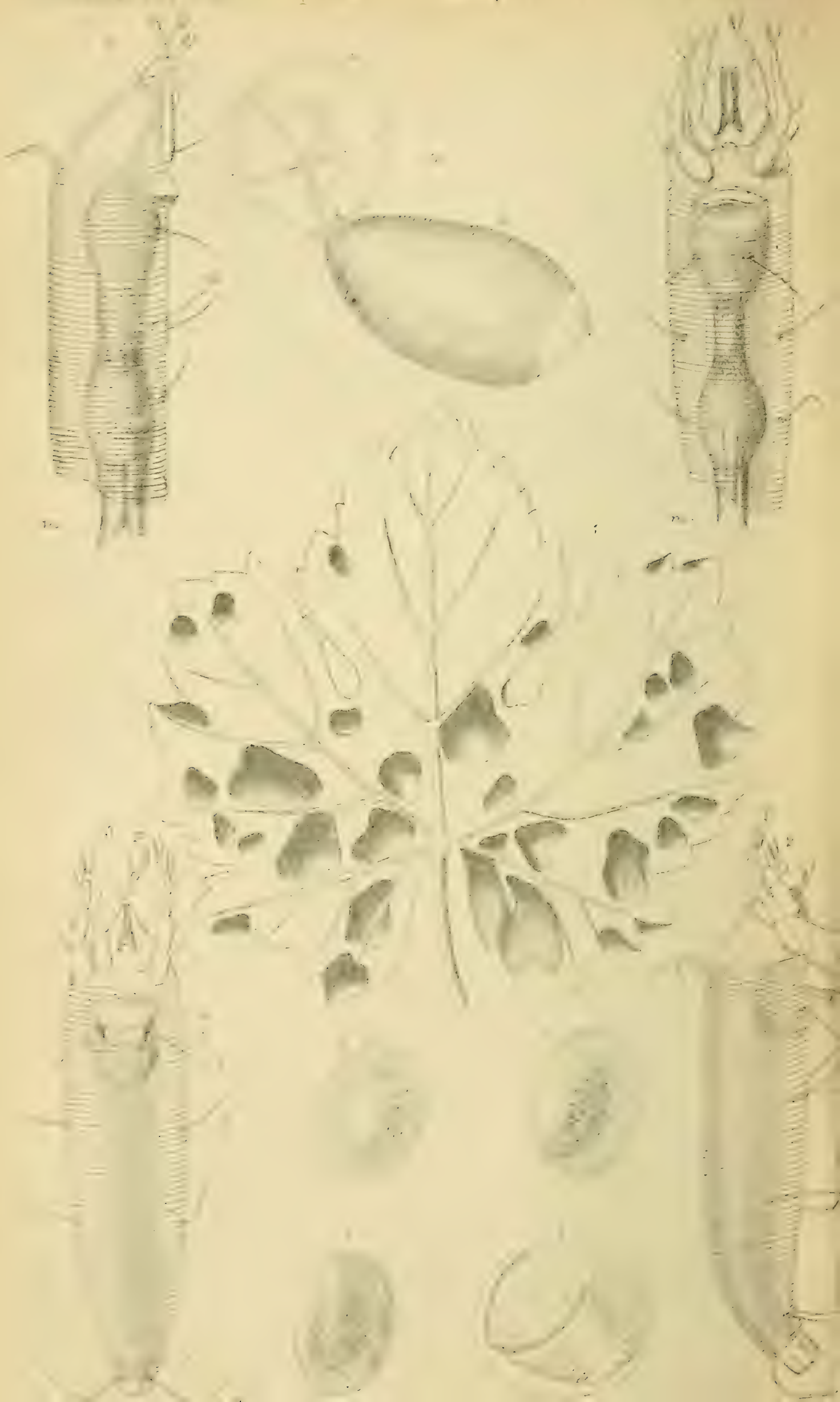
Fig. 1 represents a vine leaf slightly diseased, seen from beneath where the galls appear concave.

On the upper side the galls retain in the beginning the green colour of the leaf, turn yellowish later on, and become even brown, according to the force of the disease or the variety of the vine. Malpighi thought that the galls were caused by the drops of a liquid which he saw deposited by insects on the leaves together with eggs, and to which liquid he ascribed a fermenting action. Afterwards Malpighi's explanation did not seem satisfactory, and many naturalists studied the phenomenon of the galls of the plants, amongst whom Persoon, Fries, Réaumur, Unger, Schlechtendal, Fée, Lacaze-Duthiers, Vallot, Pagenstecher, &c.; and also, in the past few years, Landois, Thomas, and Sorauer published most important works on this subject.*

Most of them at first saw in the contents of the galls parasitic fungi, and thus were created the genera *Taphrina*, *Erineum*, and *Phyllerium*.

Palissot de Beauvais believed them *algæ*, and Unger enlargements of the leaf cells; others, directly enlarged hairs.

* *Publications.*—Malpighi, On the Excrescences and Tumours in Plants; Persoon, Sinops fungor, 1809; Fries, Observat. mycolog. 1815; Idem, Syst. mycologicum, 1825; Schlechtendal, Denkschrift der botan. Gesellsch. in Regensburg. t. ii. 1822; Idem, Botan. Zeitung, t. xxiv.; Réaumur, Mémoires pour servir à l'Histoire des Insectes, III. Mem. ix.; Vallot, Med. Acad. Dijon, 1832, part. d. scienc.; Unger, Die Exantheme der Pflanzen, 1833; Dugès, Annales des Sciences naturelles, 2me série, t. ii. 1834; Fée, Mémoire sur la Groupe des Phylleriées de Fries, 1834; Lacaze-Duthiers, Recherches pour servir à l'Histoire des Galles, Annales des Scienc. nat. 3e série, Bot. t. xix. 1853; Dujardin, Annales des Sciences nat. 3e série, t. xv. 1857; A. Scheuter, Troschl's Archiv für Naturgeschichte, Jahrgang 23, t. i. p. 104, 1857; Pagenstecher, H. A., Ueber Milben, besonders die Gattung Phytoptus, in Verhandl. d. nat.-med. Vereins zu Heidelberg, t. i. 1857–59; Landois, H., Eine Milbe (Phytoptus vitis mihi) als Ursache des Traubenmisswachses, in Zeitschrift für wissenschaftliche Zoologie von Siebold und Kölliker, t. xiv. p. 353, and following ones, 1864; Landois and Roese, Bot. Zeit. 1866, No. 38, p. 293; Thomas, Fr., Ueber Phytoptus Duj. und seine grössere Anzahl neuer und wenig gekannter Missbildungen, welche diese Milben an Pflanzen hervorbringen, con. I. Tav. in Prog. d. Realschule zu Ohrdurf, 1869; Idem, Schweizerische Milbengallen, Verhandlungen der St. Gallischen naturw. Gesellschaft, 1870–71; Idem, Milbengallen und verwandte Pflanzenauswüchse, in Bot. Zeit. 1872, No. 17, p. 282, and following ones; Idem, Entwicklungsgeschichte zweier Phytoptus-Gallen an Prunus, in Giebel's Zeitschr. f. d. gesammten Naturwissenschaften, t. xxxix. p. 193, and following ones, 1872; Idem, Beiträge zur Kenntniss der Milbengallen und der Gallmilben; Idem, Die Stellung der Blattgallen an den Holzgewächsen und die Lebensweise von Phytoptus (Zeitschrift f. d. gesammt. Naturwiss. t. xlii. pp. 513–537, 1873); T. Moritz, in Frauendorfer Blätter, p. 30, 1873; Sorauer, P., Handbuch der Pflanzenkrankheiten, Berlin, 1874, p. 165, and following ones.



At present, however, after the observations of Fée, and the researches of Landois, Sorauer, Thomas, and others, it is ascertained beyond doubt that these *cecidia* are due to the punctures and irritation produced in the texture by the *acari*, who lodge in it and live on the leaves.

Cutting a very thin lamina across a gall of a vine leaf, and placing it under the microscope, there presents itself, as nearly as possible, a picture such as drawn in Fig. 14, viz. a forest of hairs of various sizes and shapes, and between these minute animals with elongated bodies, with four legs above, with small antennæ, and segments precisely as Fée saw them in 1833.*

These are mites (*acari*), of which there has been formed a species for itself, called *Phytoptus*, which name was given to them in 1851 by Dujardin (who observed them on the linden and hazel), *in order to express that they are really and solely parasites of living plants.* These pathological plagues are thus produced.

When the animal has found a favourable spot in the leaf, it pricks its texture, and sucks the moisture of the perforated cells. The plant now remedies on its part these punctures and prolonged irritation by supplying the wounded spot with fresh nourishment; hence an afflux of substance (which can be ascertained under the microscope), and consequently an increase in the wounded cell or cells, which in consequence swell and extend externally and cause the formation of elevations. This process is clearly shown in Fig. 14, where *f*, *e*, *d*, are cells in various stages of such transformation.

The cells participating in this work are solely the epidermoid cells. Professor Landois, of Heidelberg, to whom we are indebted for the most important and complete work on the *Phytoptus vitis*,† however, attributes these projections to the underlying parenchymatic cells, and says that the epidermoid cells are never transformed into projections (*f*), which is inexact.‡

These hairs or projections can attain a length four or five times the size of the leaf to which they belong; in fact, I found some of 0·85 mm., 0·90 mm. (the average diameter of which was 0·03 mm.), on a leaf which only had a thickness of 0·20 mm. They are generally club-shaped, that is, are thicker towards the upper end, especially when young; they are more or less irregular, often crooked or curved in various ways, presenting protuberances

* Fée attributed the formation of the galls "*to an elongated larva with four legs terminating in little tufts of hair, attached to the upper and fore part of the body, which has transverse rings, and is covered with hairs.*" See Targioni Tozzetti, in the Bulletin of the Entomological Society of Italy, 1870, p. 283, and following ones.

† Summing up of Targioni in the Bulletin of the Italian Entomological Society, 1870, p. 283.

‡ "*Die Epidermiszellen des Blattes wachsen nie zu Fäden aus, sondern die Milbe sticht mit ihren stiletartigen Mandibeln durch die Oberhaut die Parenchymzellen des Blattes an.*"—Landois' work, cited amongst the Publications.

and angles. They are unicellular, that is, not presenting divisions, of which I at least saw none. Landois, on the contrary, found them to be formed of a row of elongated cells, which, to my mind, seems a mistake; and fig. 7 of his plate xxxi.* must probably have been taken from a normal hair of the vine (just as one of the hairs of my Fig. 14, which owing to a lithographic error in some plates does not reach out of the parenchyma), and not one of those pathological hairs of which we are speaking.

These hairs contain a granulated transparent protoplasm, colourless or slightly yellowish when young, and more or less opaque or yellowish-brown when old. Towards their base there is almost invariably found (toward the end of summer) an abundant quantity of starch, in form of very fine granules, similar to that gathered by me in the vessels of the higher plants.

Now and then (not always, as Landois says) I also found small crystals in the hairs, but not in the needle form of the raphides, so abundant in almost all the normal textures of the vine.

These hair crystals are in such small quantity that it does not bear out what Landois says of the great waste of tartrate of potash caused by it. The same may be said of the chlorophyll, which I found very rarely even in the young hairs, where, on the other hand, he found it in abundance. Starch I found often abundant in the primary parenchymic strata lying beneath the hairs, which unusual accumulation of material in those cells is due to the abnormal and extraordinary development of organic substance required for the formation of the hairs. The texture of the parts of the leaf corresponding with the galls (harder than the surrounding healthy one) is seen more or less changed; the protoplasma of the cells frequently lost its transparency and became dark, either orange or brown.

These changes extend frequently, with various interruptions, throughout the thickness of the lamina up to the cellular stratum, which is bordered off by the opposite side of the leaf (*g*, Fig. 14).

The plant loses, therefore, not only a considerable quantity of plastic substance which produces the pathological texture, but also organs which should produce this matter, grains of chlorophyll, of which the cells, whose protoplasm changes, are full; and it is easily understood that the harm done to the *respiration* organs must be hardly less than that done at the same time to the *assimilation* ones.

The raising of the texture towards the upper side of the leaf, that is, on the opposite one to the wounded spot, Thomas †

* Landois, Eine Milbe (Phytoptus vitis), &c., see Publications.

† He says, *verbatim:* "*Der Intracellulardruck wird dadurch einseitig vermindert werden und muss folglich eine Rückwirkung ausüben. Der nicht compensirte Druck, welchen der flüssige Zelleninhalt auf die der ausgesogenen Stelle diametral gegenüberliegende Wand ausübt, bewirkt die Fortbewegung der Zelle selbst und des ihr im Wege stehenden Theiles, der Blattspreite.*"—Bot. Zeit. 1872, No. 17, p. 286.

explains by a partial diminution of the intercellular pressure, in the wounded and emptied cells, and Sorauer * by a hardening and perhaps a cuticularization of the cells due to the action of the atmosphere, which penetrates into the structure of the wounded cells. Now, without wishing to set these causes entirely aside, I think that the same forces which produce the hairs also cause this phenomenon. In fact, the afflux of the substance which takes place towards that spot of the leaf, where a gall begins to be formed, must extend by endosmosis and exosmosis more or less to all the strata of the texture lying in the thickness of the leaf, thus offering to all the cells of the lamina in the region corresponding with the wounded spot a more than usual nourishment. Whilst therefore the cells of the under side of the leaf discharge so much material, owing to the hair production, those underlying, up to the epidermis growth of the upper side, participating in this increased nourishment must of course grow and swell, which they (to my mind at least) cannot do without producing an incurvement of the lamina of the leaf, since the texture which compasses the gall in its normal state cannot grow with the same force and rapidity on account of the lesser nourishment.

We now come to the mite, or *acarus*, the cause of the disease. This animal, belonging to the species *Phytoptus Dujardin* (*Phytoptus vitis*, Landois), is invisible to the naked eye, and its extreme smallness renders the study of the same, even with the microscope, most difficult. This explains why, notwithstanding the most painstaking researches of distinguished scientific men, there is still some doubt about its formation. The body is long, flexible, almost cylindrical, tapering off at the two extremities, which are slightly inclined towards the belly (Figs. 2, 3, 11, 12). In front it has two pairs of legs, which, when extended, project a little (about 0·01 mm.) beyond the extremity of the head. It is covered with transversal rings, which extend on one side to the insertion of the hinder pair of legs, and on the other to within a short distance of the anal opening. The cephalo-thoracic region is smooth, viz. without rings, whilst a very small depression, which, however, can always be distinctly recognized, separates it from the abdominal region. Above, nothing distinguishes the head from the thorax (which is common indeed to all arachnida, they having a *cephalo-thorax*), one superficies continues on both the segments, and the front part, which is turned down, terminates in a conical trunk.

The proboscis communicating with the head is hollow, open in front (Fig. 12, *m*), and behind terminating at the œsophagus (Fig. 5, *n*). On the abdominal side, that is, the one opposite to the dorsal, this cavity opens longitudinally, and shows an almost

* Handbuch der Pflanzenkrankheiten, p. 171.

triangular fissure; the smaller and hindmost side is represented by the under and triangular lip (Fig. 12, *i*) of the mouth. This opening is not always open, as the animal can bring the lateral sides so near as almost to touch one another, and also the sides of the angle projecting from the lower lip (Fig. 3), thus forming a tube which it uses for sucking, This cavity seems to enclose two very small mandibles *k*, *l*, lamellary, and terminating in a pointed manner, which sometimes are placed on one another in such a manner as almost to resemble a single point (Fig. 5). The animal can draw in or lengthen these mandibles at pleasure (indeed they are seen in various lengths, and sometimes not even the smallest point of them projects or can be distinguished), and they can reach up to the front end of the opening, and perhaps even beyond. With these the mite must prick the leaves in order to suck the juice afterwards with the cephalic or buccal extremity which is transformed into a tube. The length of the thoracic region, from the point where the rings end to the extremity of the head, measured on the average 0·0265 mm., in animals whose whole length was 0·09 mm., viz. about one quarter of the total length of the body. The development, however, of the curved upper or dorsal line of the cephalo-thorax of the same animals, from the spot where the dorsal bristles are inserted up to the top of the head, was on the average 0·0306 mm.

The skin of the abdomen, as said before, is externally covered with ring-like elevations, which are found flat and nearly level with the axis of the body, and cease all of a sudden at a short distance from the anal opening, leaving a small part of the belly (about 0·0085 mm.) perfectly smooth. I never counted more than seventy rings, generally only from sixty to sixty-six; their size in already developed animals varies from 0·00111 mm. to 0·0017 mm. Sorauer in the *Phytoptus piri* found, however, from fifty to eighty rings; and Landois in the *Phytoptus vitis* counted from 120 to 130, each measuring 0·0013 mm. But as, according to Landois, the average size of the longest (female) animals is 0·13 mm., with a diameter of 0·035 mm., the numbers of the rings must necessarily be a mistake, as otherwise the length of that part of the body which is covered with rings would exceed that of the whole body. Under great enlargement I observed that these rings are not smooth or uniform, but that each of them result from a series of raised corpuscles, just as Sorauer saw them in the *Phytoptus piri*.

The anal opening is placed at the lower end, in the middle of a kind of disk which is a little hollowed out, in which the body terminates.

On the body I found six pairs of bristles, two on the dorsal surface (one on the first, the other on the last ring), and four on

the belly. The first pair of the latter are placed between the ninth and twelfth ring (counting from the side where the head is), the second pair between the twentieth and twenty-second, the third pair towards the thirty-eighth ring, and the last pair invariably at the last but five rings. The hairs of the first dorsal pair are generally upright, diverging, and turned down at the end. The hairs of the last pair are nearly parallel with the axis of the body, turned towards the anus, the shortest and the closest placed towards one another (*f*, in Figs. 2, 3). Landois, however, counts on the belly only six or seven large bristles; and Sorauer on the *Phytoptus piri* counts also six pairs, only slightly differently placed, as I found them on the *Phytoptus vitis*.

The legs, colourless and nearly transparent, seem to be composed of six joints; the first, by which the leg is inserted on the thorax, corresponding with the *coxa* of insects, carries always a long bristle (Fig. 13); the second, which is the longest and most robust of all, shows two ring-like elevations, on the side of one of them being attached a second bristle; then follow three rather short divisions, the second last having a third bristle or hair pointed forward, and of such length as almost to reach to the extremity of the joint, which forms the fifth division, and on this is seen a kind of strong and pointed style in the centre, bearing five appendixes or lateral bristles, so as nearly to resemble the form of a feather. There is also a small cylinder (through a lithographic error in the Plate ending in a point) bent forward and downward, which covers, so to say, the feather or thorn, and seems to protect it. The small cylinder is a little longer than the feather, and larger (the average of three which were measured was 0·0066 mm. length, 0·00085 mm. diameter). The length of the legs in animals whose bodies measured on the average 0·90 mm. was 0·025 mm., and the diameter 0·00225 mm. at the *coxa*.

Neither description nor drawing given by Sorauer of the tarsus of the *Phytoptus piri* correspond with those of the *Phytoptus vitis* described in the foregoing, and also drawn by Landois, who, however, changes the small cylinder into a bristle. The legs are compressed at the sides, and therefore if seen sideways appear larger than seen in front.

Landois distinguishes in the legs three divisions only, but says that there are in the middle one (corresponding to our second one) two slight elevations, and in the third, two or three kind of loops or ring-like indentures. I agree that the first ones may be simple elevations, but the second ones appear to me true divisions of parts, and because of them I count five, which added to the *tarsus*, form therefore six parts or divisions for each leg.

The animal walks very quickly notwithstanding the distribution of the moving organs, which is little suited to the shape of the

body. It generally moves (raises or lowers) two legs at once, the right fore leg and left hind leg, or *vice versâ*, and sometimes (for instance, when tired) it assists with its body, putting on the ground the anal extremity, which seems to act as a venthole (*ventosa*). In this case the body, bending semicircularly, shortens itself by drawing in as a leech, and the *anus*, whilst now nearly approaching the head, becomes fixed to the ground (or leaf), whilst the animal, using it as a support, lengthens itself by advancing the fore part of its body, and repeating the manœuvre.

This *cecidozoid* when walking seems to put on the ground first the *tarsus* with its small cylinder, which, contrary to what Sorauer assumes (who believes it to be immovable), appears to me to be articulated and endowed with vertical motion, which allows the animal to assume a *quasi* normal position in that part on which the *tarsus* itself is inserted, and it is on this that the animal supports itself. The feather-like process too is articulated, and endowed with a lateral motion. The legs as well as the hind part of the body must be furnished with, relatively speaking, very strong muscles in order to allow of such a rapid motion.

Under the line of insertion of the second pair of legs at the beginning of the abdomen, exactly after the second or third ring, are the genital organs, which outwardly appear as a kind of valve or sucker, whichever you may call it, smooth, attached to the skin of the body, above, and free below, and terminating in a (circular) arc-like curve.

This valve, sometimes shut, sometimes open, covers the genital organs, hiding them almost always from the observer's eye. Once only, out of thousands of observations, I happened to see under it an oblong slit, around which ran a strong muscular ring, which had the aspect of a *vagina*.

This detail has not been drawn, because the preparation was spoiled; however, it resembled nearly fig. 6 of Sorauer.*

In one pair of animals I saw in the region of the genital organs a fissure turned upwards. Of the male organs I know nothing whatever, outwardly the sexual organs present one and the same form in all animals.

The male, however, appears to be smaller than the female, I having several times found two animals closely stretched together on their bellies, which I retained in state of copulation (in alcohol), of which one invariably was smaller than the other. If, however, one does not wish to take into account this difference in size, a very uncertain distinction, since even amongst the small animals there are some found with eggs, then I would presume to say that the male cannot be distinguished from the female with certainty,

* Handbuch der Pflanzenkrankheiten, Tav. 1[a], p. 122.

unless pronouncing males all animals in which no eggs can be discovered.

Sorauer, and before him Scheuten, found in the *Phytoptus piri* animals of two distinct forms, that is, besides those cylindrical ones described here, others larger in front and round like egg tops (*Spitzeirunde*), which were supposed to represent the male form in complete development. On the vine, however, I never could see any other but the variety of the cylindrical form, and Landois too seems only to have found this one, as he does not speak of any other. The animal of Figs. 11, 12 (laterally and in front), with valve entirely shut, may be to my mind either male or female, in which no eggs can be discovered.

Once I had the opportunity of observing very closely the *œsophagus*, the beginning of which is seen in *n*, Fig. 5; it is a tube with a very thin coat, which, as it descends, is enlarged to a kind of small bladder or bag, which is seen at the back part, towards the dorsal (at the same height about as the genital organs), which must take the place of the stomach. The intestines, however, are lost below the stomach, and sometimes only the last part, ending at the anus, reappears.

In the abdominal region there are often found oval corpuscles of various sizes, the largest in front, the smallest behind; all contained in an oblong tube or bag, which ends in the genital valve on one side, and extends towards the anus on the other. The first are eggs in various stages of development, the second the ovary. The eggs are discharged by the opening of the valve (*a*, Figs. 2, 3), and I believe I have caught an animal in the very act of expelling matured eggs, pretty far out already, as seen in Figs. 2, 3, representing the said animal laterally and in front.

The ovary occupies the abdominal region, viz. nearer the abdominal surface than the dorsal (contrary to the intestines), and in the fore part, where the most developed eggs are, it seems to fill up nearly all the internal cavity of the animal.

In the *cecidozoid* of Figs. 4, 5, the ovary was seen partly hanging out of the body, which was torn from above. The eggs when leaving the body are covered with a glutinous substance, on account of which they adhere to the objects on which they fall. Thus they are often found laterally suspended from the hairs C, where the mother must have deposited them. The egg has a somewhat elongated shape, and its contents when leaving the body of the mother appear uniform and finely granulated (Fig. 6). As it increases in volume one begins to distinguish in the interior a centre line (Fig. 8), afterwards the roundish shape of the outline of the embryo (Fig. 7); and even before breaking the vitelline membrane one can perceive inside already the animal rolled up in

itself, with the outlines of the head already sketched and distinct, and with the traces of the rings on the body (Fig. 9). In Fig. 10 an animal is represented which scarcely left the vitelline membrane *a*, to which it is still adhering (attached). In this stage no hair could be seen as yet, neither were the legs all formed.

The smallest animals I found measured 0·045 mm., and there I saw already the posterior dorsal hairs (which seem to be formed first) and the small cylinders of the *tarsi*. The largest animals I found reached 0·1513 mm. in length, and between these two limits I found every size.

I have said that this mite (*acarus*) has four legs only. Landois, however, found under these well-developed legs, two other rudimentary pairs. He relates that these acari, before they have reached their complete development and are fit to generate, pass through at least four changes: the first taking place when they leave the egg and get the *tarsus* projections; in the second they become simply larger; in the third they get the first pair, and in the fourth the second pair of rudimentary legs. Thus, he adds, the general rule, that all the *acari* when fully developed possess four pairs of legs, is fully confirmed.* I believe that Landois is mistaken; the four rudimentary legs, represented by four small appendixes, each terminating with a bristle, I have been unable to perceive. There are, it is true, sometimes found animals who might easily give rise to such an idea, because on the spot where he puts the rudimentary legs there is an elevation terminating in a bristle; but under close observation one sees that this is due to the genital valve, which is found more or less raised by the action of the body under it, which seems to prepare itself for the expulsion of eggs. Thus the bristles do not form part of the raised appendixes, but are attached to the hairs of the body, nearly at the margin of the genital aperture, as seen in Figs. 2 and 3, from which I conclude that these animals do really constitute a special genus of *acari*, which have only four legs.

These *arachnida* seem to possess a most extraordinary tenacity of life. Sorauer saw them moving the legs after being twenty, and Landois after twenty-four hours in glycerine.† From the fact of their being able to live so long in a liquid like glycerine, Landois argues that their respiration is neither pulmonary nor tracheal, that it cannot even be cutaneous, and concludes that they must breathe through the anal opening.

These *acari* are found on the vine at whatever season of the year it is examined, and Landois is in error when he affirms that they all die at the first diminution of temperature, that the eggs only remain between the hairs of the leaves, which fall in autumn,

* Eine Milbe als Urs. d. Traubenmiss, p. 357.

† Frauendorfer Blätter, 1873, No. 30. (Sorauer.)

eggs destined to produce in spring the young *phytoptus*, who climb up upon the new vine shoots. In autumn, on the contrary, these animals emigrate from the leaves, in order to nestle under the bracts which cover the winter buds, and perhaps to the roots where Moritz found them in the months of January and February, and on which they would cause the same alterations similar to those caused by the *Phylloxera vastatrix*. Between buds, gathered in January (in the midst of the cylindrical and very long hairs which are found under the scales or exterior bracts for the protection of the buds), I found a large number of these *cecidozoids*, a little lethargic, but alive, and disposed to activity when exposed to heat.

In one bud I counted more than 200 animals, in another 212, in a third 112, and in a fourth 72, and I do not think I have seen them all. Analogous observations have been made by Thomas * on the buds of *Pirus communis*, *Prunus domestica*, *Sorbus aucuparia*, *Tilia grandifolia*, *Alnus glutinosa*, *Acer campestre*, &c.; and Sorauer † found them alive between buds of trees which shortly before had been exposed to a cold of $-18°$ R.

At the first mild breezes in spring, and the swelling of the buds, the animals regain breath, and begin again to lay eggs, which they deposit direct on the young leaves of the developing bud; thus the young ones are scarcely born, when they find already within reach the food which nourishes them. With the first young leaves of the vine, indeed, are discovered the first galls under the form of small spots of a colour little different from the *parenchyma* of the leaf, scarcely raised on the upper sides, and which can be specially well discovered by examining the young vine leaf by holding it between you and the sun.

The distribution of the galls on the plant is also regulated by certain rules, which particularly depend on the conditions of nourishment of the animal, that is to say, on the one hand, of the faculty and force of the organs taking the nourishment, and on the other, of the mode of production and development of the latter. Thus it is that one can observe in May, on the stems attacked by the *Phytoptus* (when the vines are in full force of development), 1st, shoots which only present galls on the original and exterior leaf of the bud, which produced the branch and remained at its base; 2nd, shoots in which the galls, besides on the base leaf, reäppear along the branch in two or three spots, leaving long intermediate spaces with perfectly unhurt leaves; 3rd, shoots at last, in which the galls have left unhurt almost all the principal leaves, that is, those directly attached to

* Beiträge z. Kennt. d. Milbg. u. Gallm. Giebel's Zeitschr., &c., vol. xlii. p. 517, and following ones.

† Hand. d. Pflanzkr. p. 177.

the branch, and are found instead on the small leaves of the lateral small branches, growing out of the axils of the principal leaves, besides on the extreme end-bud of the shoot itself. This proves that the animal goes to lodge on the young textures which are still growing, probably because when the leaves are fully developed, their texture hardens so much, that the animal's mandibles can pierce it no longer.

And we owe probably to this circumstance, taken together with the other that the development of the plant in spring particularly seems to proceed more rapidly than the multiplication of the animal, that the disease does not cause all the harm to the vine which might be expected. In fact, we see that before the animal has multiplied to such a degree as to have to emigrate, for instance, to a lateral bud, the principal leaves of the stem are already developed in such a manner and way as no longer to allow the animal to rest thereon, and it leaves them, in fact, untouched, and goes higher up in search of a new bud.

The invasion must be very strong if the plant cannot save a good part of its leaves.

Thus, in fact, whilst in some vineyards in Favara the number of stems attacked by the galls was very large, there were very few in which the disease had spread to all the leaves. And where the evil was compassed within a certain limit, the plant did not seem to suffer much from it, whilst, however, on the stems which were almost totally invaded, the damage was so serious as to check the development of the fruit, the fruit buds having always remained so small that they could not arrive at maturity. The fundamental functions of the vine plant, as shown, that is, *assimilation* and *respiration*, are disturbed, and the sad consequences can, of course, not astonish us.

However, the assertion of Landois,* that this disease is not less damaging to the vine than the renowned fungoid growth *Oidium Tuckeri*, Berk., appears to me exaggerated. Certainly, if in one vineyard every year this disease should extend and augment in intensity, the products would be not a little diminished. However, it is a fact in Italy (at least) where the disease is old, that (as far as I know) there are few examples of excessive damage.

With regard to the remedies, Landois, assuming that at the end of autumn the animals die, suggests collecting and burning the leaves which fall in autumn and get dry under the plants, which leaves harboured the eggs from which are produced the animals in next spring; but after what has been said before, this remedy is insufficient, and perhaps is not worth anything (in dry leaves, gathered in December, I did not find any eggs, but only husks and dead animals, deformed and shrivelled in every case),

* Memoir cited, p. 353.

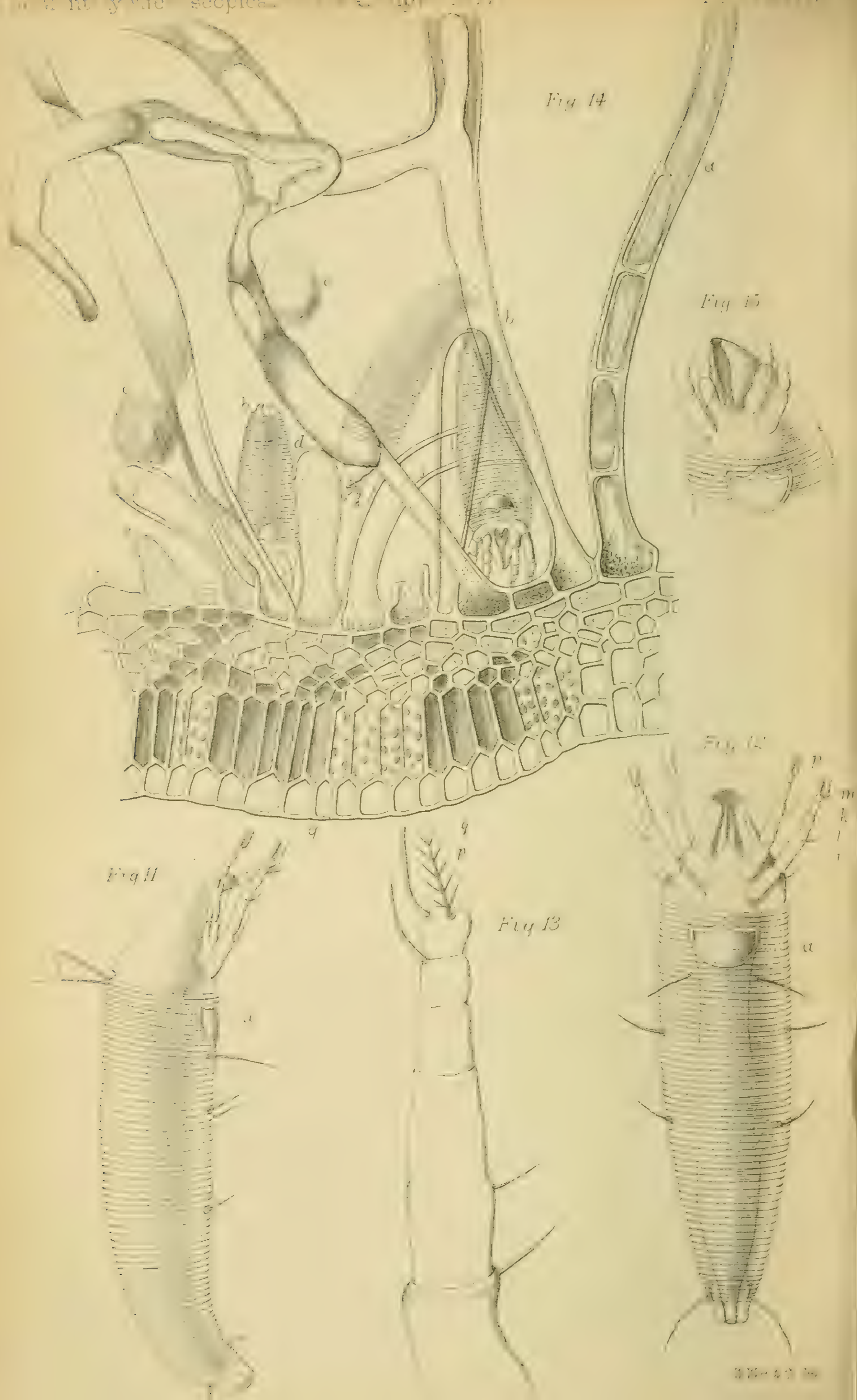


Fig 14
Fig 15
Fig 12
Fig 11
Fig 13

since these *cecidozoids* not only do not die, but take their winter quarters on the plant itself, and develop with it.

If the animals are in the buds, a large number will then be taken away with the pruning, and therefore the stems which showed the disease in the preceding summer should be kept as short as possible, the cut twigs carefully gathered, carried away out of the vineyard, and burnt. As to those portions of the branch which remain on the stem, as the remaining buds cannot be cut away under pain of almost losing the whole of the next harvest, one should in spring, when the first shoots have reached a certain length, and the galls have become apparent, cut off the leaves which are attacked most, and also the top of the most infested branches, carry them out of the vineyard, and throw all in the fire. This operation should be undertaken during the sunny hours, walking towards the sun, because the galls which at that epoch are still very small and almost green, can be easier seen by light which comes through the leaves. And this operation—easily carried out in the majority of the vineyards, where the vine is low and within reach of hand—repeated, conjointly with the short pruning, for some time, would, in my opinion, in a few years result in the destruction of this unwelcome visitor.

EXPLANATION OF PLATES CLXXVII. AND CLXXVIII,

FIG. 1.—A slightly attacked leaf seen from beneath.

FIGS. 2, 3.—*Phytoptus* laterally and belly upward, with genital valve *a* raised, and eggs *b*, which are about to emerge. (Enlargement 850 diameters.)

FIGS. 4, 5.—*Phytoptus* same position as above, with eggs, and part of ovary *m*, which projects out of the body torn above. (Enlargement 850 diameters.)

FIGS. 6, 7, 8.—Eggs in various stages of development. (Enlargement 850 diameters.)

FIG. 9.—An egg, much developed, which shows the embryo, with the traces of rings and the appendages of the head and the legs already distinct. The embryo detached itself from the vitelline membrane under repeated treatment with solution of potash and acetic acid. (Enlargement 850 diameters.)

FIG. 10.—*Phytoptus* scarcely come out of the egg *a*. (Enlargement 850 diameters.)

FIGS. 11, 12.—*Phytoptus* lateral and front views, with genital valve lowered and shut, mandibles, &c. (Enlargement 850 diameters.)

FIG. 13.—A leg much enlarged.

FIG. 14.—Section across a gall, *b*; *Phytoptus* and eggs; *f*, *e*, *d*, *h*, hairs in various stages of development.

FIG. 15.—Head of *Phytoptus*, seen across.

IV.—*On the Extrusion of the Seminal Products in Limpets.*

By W. H. Dall, Smithsonian Institution, U.S.A.

In a paper published in the American Journal of Conchology, Part 3, 1871, I brought together a summary of the various details published from time to time by various naturalists, upon the anatomy and physiology of this group. In that paper it was shown that the manner in which the seminal products were freed from the ovary and testis, and the passage by which they reached the exterior, were unknown, and from the investigations of Lankester and myself, that the existence of the oviduct figured by Cuvier,* if not actually disproved, was at least a matter of grave doubt, and had not been confirmed by any subsequent examination. Lankester † had suggested that the passage of the ova to the exterior was made through two orifices first described by him and termed "capitopedal orifices." These were said to open, "one on each side of the head in the angle formed by its junction with the muscular foot, and (internally) opening into the blood sinus surrounding the pharyngeal viscera. He also described an opening communicating between the "pericardium and the supra-anal articulated sac," or accessory renal organ. The latter I have never been able to demonstrate to my own satisfaction, but I do not assume to dispute its possible existence. Instead of opening externally in the angle formed by the head and the foot, the "capitopedal orifices," if I have correctly identified them, are situated on the back of the neck, so to speak, or more properly on the transverse portion of the integument above the head and in front of the main pericardial chamber in the angle formed by the neck and the inferior surface of the mantle over the head. Mr. Lankester found them in *Patella vulgata*, but I have never been able to detect them in the few alcoholic specimens of that species which I have been able to examine. In fresh specimens of *Acmæa patina* and *testudinalis*, I have generally been able to find them, and in the living animal they are of an orange colour. In *Ancistromesus Mexicanus* they are quite prominent in some cases and almost imperceptible in others. They also differ in character. In Ancistromesus (one of the Patellidæ), they appear as true orifices, in the acmæas they present the appearance of an elongate, narrow, glandular mass, from which, internally, a duct is not always traceable. In some individuals they appear entirely absent or abortive. My own opinion of their function is, that they are aquiferous pores, such as are common to many mollusks, through which water passes into the circulation directly in the

* 'Mém. sur les Moll.' 15, 1817.

† 'Ann. Mag. N. H.' xx, p. 334, 1867.

Patellidæ and by a process of straining through the glandular mass in the Acmæidæ. Whatever their office, it can hardly be of fundamental importance, or they would not be so frequently found in an abortive condition. Whether in some cases they may be indirectly in communication with the renal sac is of little consequence, as, in the paper alluded to, I have shown that in some genera the pericardium is so situated that there can hardly be any such communication, and in so homogeneous a group as the limpets it is unlikely that such an anatomical character, if important, should be inconstant.

Moreover, through the intricate channels alluded to, the ova which are of considerable size could hardly be propelled without some special muscular arrangement which does not seem to be present in any case examined. Anxious to set at rest a question of so much interest, and which for so many years had puzzled anatomists, I have lost no opportunity of dissecting animals of this group, especially the large species in which the characters might be supposed to be more evident. The opacity of the shell and the impossibility of getting at even the external orifices of the viscera without destroying the life of the individual, proved effectual obstacles to the study of these functions in the living animal. While in the field, from 1871 to 1874 inclusive, I made dissections of many hundreds of acmæas with no definite result, except that of finding that the sexual products appeared ripe in only a small portion of the ovary at any one time, and in the acmæas the portion most usually in that condition was the extreme right-hand part of the anterior end, immediately below the floor of the larger renal sac. No oviduct or opening was in any case demonstrated.

Somewhat discouraged by repeated failure, on leaving the field-work in which I had been engaged, the matter was deferred until a better opportunity should arise. Some time since, a large number of specimens of the giant limpet of Central America, *Ancistromesus Mexicanus*, were obtained by the Museum of Comparative Zoology from the naturalists of the 'Hassler' expedition. By the courtesy of Professor Alex. Agassiz a number of these were turned over to me for dissection.

In this species the right supra-renal sac is quite large, covering the entire superior surface of the animal between the muscular attachments. The viscera are coiled below it in the usual manner, except that in ripe individuals the upper outer edge of the ovary or testis extends rather more beyond the peripheral coil of the intestine than in most species. A section then discloses the membranes in the following order from above.

First, the external delicate layer of the mantle covering everything else, and very intimately bound together by tough connective tissue, with

Second, the superior wall of the right-hand (and only fully developed) renal sac. By means of delicate, but tough columnar walls of tissue, forming connected cellular cavities, overlaid with semi-glandular tissue for the elimination of the renal secretions, the upper wall of this sac is connected with,

Third, the floor of the sac, of similar constitution and toughness. The two are readily separated owing to the greater delicacy of the connecting tissues, but the upper wall and the mantle, and the lower wall and the tissues below it, are very intimately connected by membranous fibres of such toughness as to render their separation without injury very difficult.

A muscular band or mesentery of considerable strength, having, in the specimens of Ancistromesus examined, a width equal to nearly one-twenty-fifth of its length; extends completely around the internal viscera which are compactly bound together by similar tissue.

From the floor of the renal sac similar but short mesenteric bands extend downward to the peripheral band, radiating from the apex of the shell, and having, when in their natural position, a somewhat triangular form; the short sides of the triangles corresponding to the distal ends of the radii, and their plane surfaces being nearly vertical to the horizontal plane of the visceral mass. In the specimen under consideration there were one posterior and ten lateral bands of this nature, five on each side. In details of form and dimensions these vary in different individuals. They widen at their junction with the tissues above and below, and send off numerous fibres in all directions, and especially to the peripheral band. We thus have as it were the entire visceral mass suspended in the perivisceral cavity, free of the floor and sides of the latter (except a delicate anchoring membrane, lying vertically in the median line and connecting the median line of the visceral mass with that of the muscles of the foot), but in contact or close connection with its roof which is composed of the floor of the larger renal sac. This sac opens externally by a prominent papilla to the right of the anal papilla, while the smaller (and usually almost abortive) left renal sac, opens by a proportionally smaller papilla to the left of the anal.

The specimens were examined by cutting away the solid muscular foot, and thus exposing the perivisceral cavity without in any way lacerating its contents, sides, or upper surface. A number of individuals were dissected without coming any nearer to the object in view. At last, however, a specimen was taken up which appeared to solve the difficulties and afford the long-sought-for explanation. It was a male. The surface of the viscera with one exception was perfectly normal. On the right-hand posterior portion of the periphery of the testis, covered with its usual delicate

investing membrane, for the space of an inch from the posterior end of the median line, forward, the ducts were swollen and enlarged. They projected in a marked manner from the smooth and evenly rounded normal surface, like "varicose veins," except that the ducts are nearly parallel. In the ripest portions the delicate investing membrane of the testis had become ruptured or perforated, and the seminal matter exuding from these punctures had been solidified by the alcohol in little rounded grains or particles, which had not been disturbed by the careful manipulation of dissection.

At those points where the congested or enlarged ducts were in mechanical contact with the roof of the perivisceral cavity, that is to say, the floor of the renal sac, numerous minute, but plainly visible, oval perforations appeared. These were oblique to the general plane of the membrane, the opening on the side adjacent to the testis being usually directed somewhat backward instead of vertically downward. They had also something of a funnel shape, being larger on the side toward the testis, and some of them were twice as large as others. The largest had a diameter of ·015 inches, and would admit the passage of a fine bristle into the renal sac. On applying slight pressure from above, the fluids contained in the renal sac passed through in a minute jet. They were irregularly distributed, corresponding in locality to the ripeness of the ducts of the testis. Except where the testis in its ripe condition was in immediate proximity or actual contact with the membranes of the renal sac, *no such orifices or pores were to be found.* In the other specimens in which the testis or ovary showed none of these signs of maturity, no such orifices could be detected. The membranes in such cases presented a smooth and practically impervious surface in every part.

It would seem as if these facts gave a final solution to the difficulty as follows:

When the ovary or testis is ready to discharge its products, that portion of it which is ripe evinces its condition by an enlargement of the ducts, continuing until dehiscence takes place. Coincidently, the superincumbent membranes of the renal sac (whether by sympathy with the congestion of the seminal organ or otherwise) become lax and perforations make their appearance immediately adjacent to the dehiscent ducts. Through these orifices the seminal products make their way. A contraction of the pedal muscles would be sufficient to cause the ejection. After reaching the renal sac, the question of the extrusion of the ova or semen presents no difficulties. The same agency which empties the sac of its secretions through the renal papilla would suffice to eject the seminal products, which floating in the water would cause the fertilization of the ova as in the case of Chiton.

The rarity of individuals in a ripe condition in collections may be due to their repairing below tide marks at such times, and hence avoiding the collector.

The method above suggested is paralleled in numerous other invertebrates, and even some fishes, with non-essential differences of detail. The specimen referred to has been submitted to several naturalists who agree as to the facts.

While additional evidence is desirable in corroboration, I feel tolerably confident of the correctness of the inferences drawn from the above facts, which furnish an explanation at once simple and in accordance with experience in other cases, of a very puzzling question.

I may add, that the localized turgidity or swelling of the ripe seminal ducts had been previously observed by me on other occasions among specimens of *Acmæa patina*; but having dissected them in most cases from above, removing the membranes not connected by tissue with the ovary, and looking more particularly for a permanent duct or passage, the perforations of the renal membranes were likely to, and did, entirely escape my notice.—*Proceedings of the Academy of Natural Sciences of Philadelphia.*

V.—*Notes on "Inclusions" in Gems, &c.* By Isaac Lea, LL.D.

In a communication on microscopic crystals contained in gems, which the Academy of Sciences of Philadelphia did me the favour to publish in its 'Proceedings'* a few years since, I gave some figures of these crystals, which I have frequently since verified. I then observed that, beside these intercrystalline forms, there were in most gems cavities frequently so numerous that they amounted to tens of thousands.

Since the period of the publication of my paper, I have made very large additions to my cabinet of gems, and particularly those of the Corundum group, sapphires, rubies, and the so-called Oriental topaz, Oriental amethyst, Asteria, &c. In the numerous fine blue sapphires of my collection, I have rarely explored one without finding numerous cavities, and ordinarily also finding the beautiful microscopic acicular crystals, which, when the specimen is cut *cabochon*, cause the three bands, and these by crossing form the star in Asteria. The cuneate microscopic crystals are also quite common.

Cavities, with or without the fluids, are so frequent in crystals, from the soft calcite to the hard corundum, that little may be said as to their occurrence, as they are so common.

* February and May 1869.

Cavities in quartz crystals enclosing fluids have been observed by the older mineralogists, but the kind of fluid, and gas or air, was not ascertained by them. Sir Humphry Davy, in 1822,* investigated the contents of these cavities, and found them generally pure water. The gas-bubbles were sometimes found to be "azote." Sir David Brewster, in 1823,† published a memoir of great research and value. He first had his attention called to the examination of fluid in cavities by the explosion of a crystal of topaz when heating it. He found cavities and air-bubbles in nearly twenty different substances, and these inclusions were carefully examined by him. In some of these cavities he observed two fluids ‡ and crystals, and these are figured in his plates. Subsequently, Mr. Sorby published a long and admirable paper § on fluid cavities and crystals in minerals, with numerous and interesting figures. He considered that the cubic crystals were probably chloride of sodium. In his investigation he proved, by forming artificial crystals, that, in a natural state, the fluid cavities, with their "inclusions," must have been formed by aqueo-igneous forces. He gives a figure of fluid in mica, but I have never seen any in that mineral, although many hundreds have passed under my microscope in looking after crystals of magnetite, &c. Mr. Sorby also published a paper on cavities in quartz in the 'Phil. Mag.' vol. xv. p. 153; also with Mr. Butler in 'Proc. Roy. Soc. London,' vol. xvii. p. 299. Kirkel on "Microscopic Minerals," Neues Jahrbuch, 1870, p. 80, mentions bubbles and cubic crystals in quartz. He found iron glance and fluid in Elæolite = Nephelite. In emery, from Naxos, he found fluid in cavities.

In 1872, ‖ Mr. Sang published an account of water in cavities of calcite.

Very recently, Professor Hartley, King's College, London, has published a very able paper on the subject of the fluid in quartz, &c.¶ He says that Simmler in 1858, offering an interpretation of Brewster's observations, concluded that the expansible liquid was carbon dioxide. Professor Hartley states that in many cases the liquid in quartz is water, but that in some cases he found the two fluids; and his very satisfactory and careful experiments show conclusively that the most volatile of the two fluids is carbonic dioxide. He found in every experiment that the fluid disappeared when exposed to 31° C., and reappeared on cooling. Professor Hartley accords with Mr. Sorby in his reasoning that

* 'Phil. Trans.' 1822.

† 'Trans. Roy. Soc. Edin.' 1823.

‡ These two fluids Professor Dana without any analysis has called Brewsterlinite and Cryptolinite.

§ 'Journ. Geol. Soc.' vol. xiv., 1858, "Micro-structure of Crystals."

‖ 'Proc. Roy. Soc. Edin.' p. 126.

¶ 'Journ. of the Chem. Soc. London,' February 1876.

"at the time of its assuming the solid state, the solution endured a high temperature."

Calcite has been found to contain nearly a quart of this fluid,* but it is not as common to be found in small cavities as it is in quartz.

Fluorite.—Cavities in this mineral are rarely found, but they are sometimes seen with fluid and air-bubbles.

Apatite.—I have never observed cavities in this mineral, but I have not given it much attention in microscopic examinations.

Feldspar Group.—In a former paper† I gave the result of the examination of many specimens of various species. Since then I have examined numerous specimens of Labradorite, and found no cavities, but the black crystals were very numerous. In the moonstone of this country I have not observed cavities or crystals; but in two specimens, out of about one hundred from Ceylon, I have seen a series of very regular quadrate cavities or crystals which do not appear to have any fluid.

Tourmaline.—This interesting mineral is found beautifully crystallized, and of almost all colours, white, brown, green, red, black, &c. The finest are found at Mount Mica, near Paris, Maine.‡ Some of these specimens have small internal elongate crystals, which are terminated. A red specimen (Rubellite) in my collection has many irregular cavities. One green one from Ceylon has cavities with fluid, and another has very minute black acicular crystals in one direction. In brown crystals from Lower Dianburg, Carinthia, there are rough objects in the interior, evidently another mineral enclosed, which do not require the microscope to detect them.

Cyanite.—Of the white and the blue varieties I have not observed any well-defined cavities or crystals; but in the grey-bladed cyanite, found at Cope's Mills, near West Chester, Pennsylvania, there are always, I believe, small black masses which do not take a regular form, but are usually elongate. These may easily be detected by splitting a crystal along its eminent cleavage, and examining the cleavage face with a lens of small power; but a higher power is preferable.

Quartz takes upon itself many colours. In it are found cavities in very great numbers, particularly in the clear fine crystals. Those which exist in such an abundance in Herkimer County, New York, and which are so limpid, and finely and doubly terminated, are sometimes furnished with thousands of cavities, even in small specimens, and these are of many various forms, frequently con-

* Specimen in the collection of the late Dr. Chilton, of New York.

† 'Proc. Acad. Nat. Sci.' May 11, 1869.

‡ Dr. Hamlin has published a beautiful little work on the Tourmaline, with illustrations.

taining fluid. In some cases the fluid may be seen to move by the unaided eye. In these Herkimer crystals, carbon in the form of anthracite is of very common occurrence, and in one of my specimens a small portion moves in the fluid of a cavity. These cavities often exist in an entire sheet, almost across the prism of a crystal.* In smoky quartz † these cavities are much rarer, as also in amethyst and wine-colour and green quartz. The amethyst is frequently penetrated with crystals of rutile, and these are often very large, sometimes one to four inches long. The Chester County specimens usually have numerous curved filamentous crystals, easily detected with a common lens. In Way's Feldspar Quarry, near Dixon's, Delaware, there is a very peculiar form of quartz, which is nearly transparent, but somewhat clouded. The fragments of all sizes, from that of a pin's head to that of a small walnut, are enclosed in a mass of Deweylite. These fractured pieces are of indefinite forms. They are evidently cryptocrystalline, and look as if they may have been heated and suddenly cooled, and thus fractured. When these pieces are subjected to a high power, there may be detected in them very minute oval cavities in great numbers, and the major axes usually placed in one direction I have never seen cavities in milky quartz or blue quartz. Sir David Brewster found many cavities in rock crystal from Quebec with "water and mineral oil." ‡

Topaz.—In the various beautiful crystals which this mineral presents, there are frequently found cavities with fluid, and sometimes in this fluid may be seen the cuboid crystals described by Sir David Brewster. He found a single fluid in some cavities, and in others two fluids with "air-bubbles." He says the fluid does not expand with heat. The Saxony transparent white crystals sometimes have cavities, as well as those of pale wine-colour. The Brazilian gold-yellow specimens have these cavities very frequently. The clear pinkish are more free from them. I have never observed any microscopic acicular crystals in topaz.

Emerald, Aquamarine, and Beryl—constitutionally the same—differ very much in regard to their possession of cavities and their commercial value. So far as I have been able to examine fine specimens of emerald, it is rare to see one without cavities. One which I have, of very fine colour, has many cavities of various forms, in which are included a fluid enveloping generally two perfect cubic crystals of an unknown mineral. In all cases in this specimen, the second crystal is much the smaller.

In aquamarine, cavities are not frequent, and in beryl I have

* Sorby, 'Journ. Geol. Soc.' 1858, found many cavities, and thinks that the cubic crystals enclosed are probably chloride of sodium, as mentioned above.

† The smoky quartz of Pike's Peak has hexagonal spangles, which may be mica.

‡ 'Trans. Roy. Soc. Edin.' vol. x.

detected them only in a specimen from Unionville, Penn. In this there is a biangular cavity with a small cubic crystal at an inner angle. Throughout the mass there are small suboval cavities.

Garnet.—As a precious stone this is by no means rare, but it is lustrous, and of a fine colour. Cavities and microscopic crystals are very common in this gem.* The cavities are usually irregular and rough, and never to my knowledge have fluid. On a polished surface of a piece of garnet from North Carolina, nearly an inch long, the reflexion of these crystals covered the whole surface with prismatic colours.

Cinnamon Stone.—This beautiful variety of garnet, from Ceylon, as far as I have been able to observe it, and I have some twenty cut specimens, and numerous rolled pieces, has irregular cavities and some crystals, as I have stated in a former paper.

Zircon.—With its high refractory power, this is used frequently as a gem, and sometimes sold as a diamond when white and perfectly transparent. One of the numerous specimens which I have examined has cavities † and microscopic crystals, and a specimen from Ceylon has remarkable dark brown, elongate, fusiform spots, with numerous dotted ones intervening.

Chrysoberyl.—The few specimens I have of this beautiful gem have neither cavities nor microscopic crystals, but Brewster observed "strata of cavities and both the fluids."

Chrysolite = Olivine.—In some of my specimens I have observed small cavities with fluid. Brewster met with them containing "fluid and bubbles of air."

Spinel.—This gem occurs of several colours. The Spinel ruby, so called, sometimes is very close in colour to the true ruby, but it has not by any means the depth nor brilliancy of the true ruby. In a pale-green specimen of great beauty which I have received recently from Ceylon, I have not been able to detect cavities or crystals. In my former papers I have expressed uncertainty in this matter.‡

Iolite.—This gem is inferior in hardness, colour, and specific gravity to sapphire, but is valued for its peculiar change of colour, being dichroic. One of my specimens is without any inclusions. The other is filled with blue four-sided prismatic crystals, which are long, and enclosed in a nearly white subtransparent mass. These crystals are sometimes broken and their parts prolonged in the mass, and they are all lying in nearly the same direction.

Turquoise, with its peculiar and agreeable blue, is never transparent, and neither cavities nor microscopic crystals are found in it.

* 'Proc. Acad. Nat. Sci.' February and May 1869.

† In a specimen in Dr. Leidy's fine cabinet there are anastomosing cavities.

‡ 'Proc. Acad. Nat. Sci.' February and May 1869.

Opal.—This exquisite gem, which displays such brilliant colours, is very highly valued. It is but little harder than glass, and is indeed considered as volcanic glass. Its remarkable flashes of colour are attributed to fissures, in accordance with the theory of Newton's coloured rings. I have never been able to detect either cavities or minute crystals in this beautiful gem, except in two cases. One of my specimens has a brown, terminated crystal, a six-sided prism of an unknown substance, about one-fifth of an inch long, and terminated by a single oblique plane; the other has several smaller ones.

Lapis-lazuli.—This was used by the ancients as a favourite gem, but it is not now valued as such. I have not been able to detect cavities or minute crystals in any specimen in my possession.

Corundum.—This very interesting mineral, when in perfect transparent crystals, is highly valued as a gem, under the name of sapphire, ruby, &c., according to colour. When yellow, it is called Oriental topaz; when purple, Oriental amethyst. When purely white it is sometimes sold as a diamond. In this country we have two localities only of corundum where any large quantity has been found, that of Chester County, Pennsylvania, and Franklin County, North Carolina. From the mines in Chester County, several hundred tons have been taken, but no transparent crystals. Some opaque ones are bluish and some pinkish. The North Carolina locality has produced some very large crystals, and numerous small ones. Of the latter there have been found many quite pure and transparent, and these are sometimes blue and sometimes red. But none of them yet found are of value as gems. The fine sapphires and rubies are chiefly from Ceylon, and they form some of the most beautiful objects in nature. I have many of these in the form of worn pebbles, and some in fine hexagonal form, as well as hundreds of cut specimens. I have examined carefully more than one thousand specimens, with a view to discover whatever "inclusions" they might possess. In a communication to the Academy * I described and figured some microscopic crystals in these and other gems. Since then I have added a very large number to my collection, and among these several hundred large and small transparent crystals. In a careful microscopic examination of these, I found a large number which contain cavities and minute crystals, the former sometimes scattered irregularly through the mass, and sometimes forming a sheet or film. These cavities are of all forms, but usually subelliptical; sometimes tubular, and these tubes frequently anastomose in a very beautiful manner. These cavities are so numerous that they frequently give a cloudiness to the specimen, which is less valuable as a gem, but most interesting in a scientific point of

* 'Proc. Acad. Nat. Sci.' 1869.

view. In some specimens these cavities exist by tens of thousands, and Sir David Brewster stated that in a specimen under his observation there were about 37,000 of these cavities. I am sure that in one of my large cut specimens there must be more than double that number. It is a very common thing to see hundreds at a time of these cavities in the Ceylon specimens, partly filled with the fluids previously alluded to in these notes. But it is quite rare that they are found in the specimens from North Carolina. Still I have seen them in the transparent small fragments of deep blue crystals, and sometimes in the transparent light-coloured ones. In one specimen of the latter I discovered some most interesting cavities, which contained, beside the fluid, each a single cubic crystal. I had never observed an included crystal in any cavity in the numerous Ceylon specimens which I have examined. These cubic crystals have the exact form and appearance of those in the emerald described herein.

In regard to the microscopic crystals in sapphire, having described and figured them in the papers before alluded to. I have little to add now. Further observation has confirmed what I then stated regarding the radii of Asteria. Very recently I have received a number of these Asteria of various colours, blue, purple, white, red, and dove colour; several three-quarters of an inch in diameter. The red and purple specimens are of peculiar beauty, and when examined in the sun, or any strong light, they both exhibit the microscopic acicular crystals with peculiar beauty, displayed as they are in hexagonal form, and reflecting the spectral colours. The ruby Asteria is certainly among the most beautiful objects in nature, and the purple are very little less so.

In some crystals of corundum there is a strong bronze reflexion, and this is the case with some of the large hexagonal crystals which were imported by Mr. S. S. White from India for commercial purposes, and which he distributed with so much liberality to our mineralogists. These bronze crystals have also been found at the Black Horse and Village Green localities in Delaware County, Pennsylvania. When examined with a good power, these bronze reflexions are at once seen to be caused by minute acicular crystals, and these may sometimes be seen in bunches.

A pale ruby, "Rubicelle," which I lately received from my friend Hugh Nevill, Esq., Ceylon, about three carats, is a most interesting and beautiful gem. It has the depth and brilliancy almost of the diamond. It is nearly of a rose colour, and is perfectly transparent. It is cut with a top table and not entirely symmetrical. Its refractive power is unusually great. Yet when this brilliant transparent gem is examined with a high power and strong light, the whole mass may be seen to be filled with long acicular crystals in three directions, parallel to the prismatic

planes, and interspersed are numbers of very minute and delicate cuneiform crystals.* It has also a small cloud of exceedingly small cavities.

Another remarkable specimen may be mentioned here, which has small cavities and minute microscopic crystals. It is of a pale yellow or straw colour, and of a depth and brilliancy scarcely exceeded by the diamond.

During the examination, about two years since, of some hundreds of small crystals of sapphire, perfectly transparent to dark blue, I discovered one which had very singular plumose impressions on the planes of the prism. This induced me to examine carefully all those which I subsequently procured, and I have now over a dozen specimens which exhibit this very singular character. I am entirely at a loss to discover the cause of this form of minute impressions on so hard a substance. It evidently has been formed by some collateral mineral substance, against which the molecules in crystallization have been arranged.

Diamond.—The hardest of all substances stands first among gems. It has not, however, much interest to the microscopist, as no cavities with fluid have been, so far as known, observed; nor has it included crystals of foreign substances. They are often very imperfect, containing rifts and discolorations. Some of my specimens have beautiful triangular impressions on the surface of the planes. My friend Dr. Hamlin, of Bangor, Maine, is engaged on an extended work on the diamond. Such a work is much needed, and I know no one as capable as he to accomplish it. This gem sometimes occurs of various colours. In my cabinet I have six different colours.—*Proceedings of the Academy of Natural Sciences, Philadelphia.*

VI.—*A Mode of altering the Focus of a Microscope without altering the Position of either the Objective or the Object.*

By M. Govi.

In working with the microscope, above all when we utilize it for comparing measures of length, it often happens that after having focussed it upon the first object, it is necessary to apply it to the observation of a second one, which is not absolutely at the same distance from the objective as the first. Then it becomes necessary to alter the focus of the instrument in order to have a clear image of the object, and this is done either by a movement of the whole microscope (i. e. the tube), or by an alteration of the eye-piece or the objective, or by a movement forwards or backwards of an inter-

* 'Proc. Acad. Nat. Sci.' May 11, 1869.

mediate lens (as in the *parfocal meroscope* of Porro). In all these cases, no matter how much care may have been taken in the construction of the apparatus necessary for these alterations, it is almost impossible to avoid very slight deviations of the optical axis of the microscope, and hence we cannot count on the perfect exactitude of comparisons which demand an absolute invariability of the direction of this same axis. If instead of changing the focus by means of altering the optical apparatus we obtain the alteration by elevating or depressing the object itself, it may happen, and it does occur often enough, that the masses to be displaced being considerable, the displacements occur irregularly by a series of jerks, with flexion of the object, and hence with an uncertainty or an alteration of the length to be measured. Moreover, one can hardly focus one of the extremities of a scale without at the same time altering the focus of the other end, which causes a loss of time, and prolongs beyond measure operations which ought to be rapidly performed.

It was therefore desired to find a means of altering promptly the vertical focus of the microscope within certain limits, without having to fear either a change of direction of the optical axis of the instrument or any alteration whatever in the length to be measured. It was then necessary to consider how this could be done without interfering either with the optical part of the instrument or with the object. And it seemed almost impossible.

But on reflecting, it appeared that the interposition between objective and object of a medium more refractive than air, bounded by plane and parallel faces normal with the axis of the microscope, would affect the object. Thus there is an apparent raising of the object:

$$d = e\frac{n-1}{n}$$

where d is the amount of elevation produced, e the thickness of the medium introduced, and n its index of refraction compared either with the air or a vacuum.

It will suffice in fact to place beneath the objective a plate with plane and parallel surfaces, and of variable thickness, to bring readily into the focal plane of the eye-piece the image of objects situated at different distances in front of the object-glass without altering the position of either the objective or the object. But it was, if not impossible, at least extremely difficult to obtain solid plates with plane and parallel faces and with a thickness which could be altered at will, which withal were perfectly homogeneous throughout, and maintained their perpendicularity in their initial inclination in relation to the optical axis of the microscope.

Fortunately a well-known property of liquids—that of leaving their surface during equilibrium perfectly horizontal—permits us

to obtain with them what we could hardly hope to get with solids. Hence it is only necessary to employ a liquid layer placed, in a sort of cup with a transparent bottom, beneath the objective. For here we have a refractive plate whose thickness we can increase or diminish, and whose surfaces keep up constantly the same relation with each other and with the optical axis of the microscope.

If then one establishes between the objective and the object a reservoir sufficiently large (in order to avoid capillary attraction), closed below by a plate of glass with horizontal surfaces sufficiently parallel, and if then one introduces a liquid of the index n, which one may vary the level of at will by aid of a *plongeur*, or by means of a communicating vessel filled with the same liquid, one may always by variations in the weight of the refractive layer bring to the same vertical distance objects whose real distances differ by quantities more or less considerable. The limit of these *accommodations* is given by the value of d, calculated from the formula already given. And as one hardly has recourse to liquids whose index of refraction is less than 1·3335 or more than 2·000 this limit would always be comprised between about a quarter and a half of the *maximum* thickness of the liquid contained in the cup.

It must be understood that it is not requisite to take account, in this valuation of d, of the constant displacement produced by the layer of glass and by a layer of liquid which it is well to have above it in order that the variations of thickness may take place in the same refractive substance.

In cases where the objects to be observed are directly plunged in a liquid, this liquid might be made to serve the *focalization* of their images.

The extreme mobility of most liquids demands great steadiness in the "cup" which carries them; without this the agitation of their surfaces would prevent the proper formation of images, just as it not unfrequently happens in the mercury baths that are used for astronomical purposes. If there are no trepidations, the observation of transparent or opaque objects is conducted as easily through the liquid layers as through the air, and the loss of light which results from successive reflexions does not materially affect the clearness of the images.

A slight defect of parallelism between the inferior surface of the "cup" and the upper surface of the liquid should not affect the exactitude of the focus, whilst perfect horizontality of this latter gives this slight defect a constant value, whatever be the thickness of the liquid layer interposed. It produces only in this case a slight lateral displacement of the images, which, being the same for all, alters in nothing the value of their relative distances.—*A Paper read before the French Academy*, February 19, 1877.

PROGRESS OF MICROSCOPICAL SCIENCE.

The Structure of the Echinoids.—It seems that M. S. Lovén has published at Stockholm an essay on the above subject, which is of some importance. It is illustrated by fifty-three plates, and is likely to be of interest not only to the naturalist, but also to the palæontologist. The 'American Naturalist' (February) says that it is chiefly zoological in its character, the text and plates are mostly devoted to a discussion of the homologies of the shell of the sea-urchins, particularly those forms related to extinct genera of Echinoids. Comparisons are also instituted with the classes of Asteroids (star-fish) and Crinoids, which will, if we mistake not, be found of much use to palæontologists. Especial attention is devoted to certain organs called Spherides, grouped around the mouth of sea-urchins, for the discovery of which naturalists are indebted to Professor Lovén. But the most interesting portions of the work are the exquisite drawings illustrating the anatomy and distribution of the nervous system and the water system of vessels. We have here for the first time, clearly shown, the more intimate relations of these organs. The plates are abundant and beautifully executed, the lithographs rivalling in clearness and delicacy the best steel engravings.

The Position of Sponges.—Professor A. Hyatt, who lately read a paper on this subject before the Boston Society of Natural History, stated that he considered they formed the type of a new sub-kingdom of animals. He treated at some length on their mode of development. The paper will be published in the Society's 'Transactions.'

The Oscillatoria and Bacteria formed the subject of a recent paper before the Boston Natural History Society, by Professor W. G. Farlow.

Development of Scleroderma verrucosum.—In the 'Annales des Sciences' (1876, p. 30) an important memoir is published on the above subject by M. N. Sorokine, which is thus well abstracted by the 'Journal of Botany' (January). It says that attention is first directed to the two states, thread-like and lash-like, of the mycelium, upon which no organs of fecundation were discovered. In a very early state the mycelium consists of a cushion of short interlaced dichotomous filaments, which afterwards become still more interlaced, so that it has somewhat of a spongy structure consisting of masses of interlacing fibres with frequent cavities. Fine branches are now given off from the filaments which direct themselves into the nearest cavity, and when there bifurcate at their extremity, one of the bifurcations twining round its fellow; this is the commencement of the hymenium, which increases quickly by the formation of other filaments from the original one, and the young plantule now consists of a great number of hymenial masses contained in a darker-coloured common envelope, the intervals between the former being occupied by filaments which give origin to the capillitium. The filaments of the capillitium become transversely partitioned, and some of the segments are thickened, while

others remain thin and transparent, and during the time the spores are ripening the latter are converted into mucilage, the simple or branched thickened segments remaining. The origin of the basidia is as follows: Immediately after the development of the hymenial masses, some of the filaments of which they are composed bear branches which direct themselves towards the centre of the mass; these branches divide transversely, and the terminal cell becomes elongated and is soon seen to carry four round pedicellate spores, the nucleus of the basidium disappearing before the spores make their appearance, as Woronine has already observed in Exobasidium. M. Sorokine cannot share the opinion of Berkeley and Tulasne that the spores do not arrive at their full development while attached to the basidia, but that they fall off and draw elements of nutrition from the nidus in which, when free, they find themselves. On the contrary, he thinks that the spores do not fall until their development is complete. He believes also that, contrary to what has already been held, there is no regularity in the order of local maturation of the hymenial masses. The so-called "nucleus" of the spores is shown to be of oleaginous nature, since it dissolves in alcohol.

Experimental Observations on Mosses.—Some experiments of a very interesting nature were conducted lately at Strasburg in regard to the "artificial production of a protonema on the sporogonium of Mosses," by Professor Dr. Stahl. They are described at some length in the 'Journal of Botany' for January, by a writer who signs himself G. R. M. M. He says, among other things, that as Brefeld's views on the alternation of generations of the Ascomycetes take the relations existing in Vascular Cryptogams as a point of departure, it was first of all the question whether the production of the sexual generation was necessarily bound up with the formation of spores, or whether perhaps, under normal conditions, other parts of the spore-bearing plant were not in a position to produce the sexual plant. To settle this question by experiment no better object could be found than the sporogonium of Mosses, and after much searching Dr. Stahl found that of *Ceratodon purpureus* to be the most suitable for conducting the necessary investigations. The experiments were instituted thus. The sporogonia were partly extracted from their mother-plants—a process which can usually be effected without injury—and partly cut off directly above the point of their connection; all were placed on damp earth under a bell-jar, and exposed to diffused daylight. Not a few soon showed clear signs of decay; others again remained green and unaltered in shape, with the exception of some deformations of the capsule. After two or three months, however, dense protonema-formations, on which leaf-bearing Moss-plants were already formed, proceeding from the cut surface of the seta, extended over the earthy substratum. From microscopic examination it appeared that the protonema-threads owed their origin to the chlorophyll-containing cells within the seta, longitudinal sections of which showed the way they arise. After a lapse of three months the contents of most of the seta-cells had died in both the forms of cultivation, but here and there were found, extending along the whole length of the seta,

between the dead thin-walled cells of the fundamental tissue, cells which not only retained their protoplasm and chlorophyll, but had increased the volume of the latter in particular in a striking degree. These occurred in the decayed tissue, sometimes isolated and sometimes in groups, the individual cells arranged beside or above each other. Even from cells in the wall of the capsule Dr. Stahl found protonema filaments to proceed. From Pringsheim's observations, as well as from those here communicated, the conclusion is clearly arrived at that the transition from the spore-bearing generation to the sexual generation is not necessarily bound up with the formation of spores, but that, under conditions injurious to the formation of spores, different cells, both of the seta and the capsule, are capable of producing a protonema.

The Origin of Pycnidia.—A difficult research is that which has been made by Dr. H. Bauke, and which is recorded in the 'Nova Acta' (Band 36), Dresden, 1876. The original paper is abstracted at considerable length in the 'Journal of Botany' (January), from which the following conclusions may be taken as stated by the author:—"As to the question whether the Pycnidia are independent organisms, or whether they belong to the Ascomycetes, these researches prove the second of these alternatives to be correct. The cultivation of the Ascospores of *Pleospora polytricha*, *Cucurbitaria elongata*, and *Leptosphæria* (*Pleospora*) *Doliolum* regularly yielded Pycnidia—in the first of the three species named such bodies were up till now unknown; in this case the direct connection between the sown Ascospores and the Pycnidia was each time established. From *Pleospora herbarum*, in spite of numerous cultivations instituted for the purpose of studying specially the development of the Perithecia and the Pleomorphism of this fungus, I obtained only twice Pycnidia. . . . In the cultivation of *Melanomma* (*Sphæria*) *Pulvis-Pyrius* and of *Pleospora pellita* a dense mycelium was regularly produced, on which in the latter species the Conidia drawn by Tulasne appeared in masses, but no Pycnidia, which were indeed never found on either, &c. From *Cucurbitaria Laburni* and *Pleospora Clematidis* the same results were obtained, namely, no Pycnidia. Pycnidia appear as parasites on other Ascomycetes (as in the case of *Cincinnobolus* and *Erysiphe*) only as distinct exceptions."

Tubular Degeneration of the Medullary Nerve Sheath. — The 'American Journal of Insanity' (January 1877) says that in partial softening of the spinal cord, and in grey degeneration, Professor Arndt observed—by examining transverse sections, coloured with carmine—the medullary sheath to consist of concentric layers. As the medullary substance showed an inflated condition, there was no doubt of a pathological alteration; but still, Arndt believes that it also establishes the true structure of the sheath, which normally, very probably, grows by forming concentric layers.

Are Volvox globator and Sphærosira volvox distinct Species?—This question has at length been answered in the negative by Mr. W. H. Gilburt, who has a short but important paper on this question in the 'Journal of the Quekett Club' (February 1877). The relationship

was suspected years ago by Mr. Busk, but it is now clearly defined. Mr. Gilburt says that he lately obtained some water from a pond in Epping Forest, near Walthamstow, containing *Volvox globator* in great numbers. On first looking at them, nothing particular was observed, save that many were decaying, and were occupied by one or more rotifers and their eggs. Making a more careful examination, he found that in some of the vigorous and more active ones, a difference between the macro-gonidia existed—some of them being smaller in size, lighter in colour, and the disposition of their gonidia less regular. Using a higher power, the difference became more marked, and under a power of 350 diameters those which departed from the supposed normal character appeared as the author has represented them in the drawing which accompanies the paper, a sphere as an ordinary *Volvox*, but that some of the gonidia were missing, and their places occupied by compound bodies, in this and every other respect agreeing with the figures of *Sphærosira* as given both by Ehrenberg and Busk. Submitting them to pressure so as to rupture the cell-wall, he found that the compound bodies referred to escaped; and then appeared discoid in form, and composed of about thirty cells, flask-shaped, having a nucleus, being attached to each other by the smaller end, and furnished with abundant vibratile cilia, which can be seen in both aspects as figured. The action of the cilia imparts a slow, revolving, wheel-like motion to the group, but with very little progression. This motion can sometimes be seen while they are still within the containing sphere. In a single *Sphærosira* as many as fifty-five of these compound bodies have been found. One most remarkable feature is, that while the *Volvox globator* may contain from two to seven macro-gonidia, yet in only two instances has he found more than one *Sphærosira* among them; though a very large number have been examined for this special purpose.

The Formation of Spores in Lichens and Fungi.—A valuable essay on this subject has been translated from the French of M. Strasburger into 'Grevillea' for March. We can only abstract a few of the observations, more especially with reference to *Physica ciliaris.* The author says with regard to this species his own special researches show that the primitive nucleus really exists, and is found in the upper portion of the claviform ascus before the production of the spores. The ascus is filled with a protoplasm nearly uniform in density, and possesses a thick and very turgescent wall. The nucleus is spherical, especially dense and refractive in its upper part, as the examination of preparations preserved in alcohol demonstrates. The ascus augments in volume, the primitive nucleus disappears, and eight spores simultaneously arise in the superior part of the ascus. These spores approach each other closely, and absorb for their formation nearly all the superior protoplasm of the ascus. The spores appear complete. In the centre of each of them we observe a denser, although badly circumscribed spot. The young spores are at first solid, and surround themselves very rapidly with a colourless membrane of cellulose, which quickly increases in thickness. At the same time they increase in size, and their protoplasmic contents retire towards their walls. The denser, and at first central portion, which is an

irregular or stellate granule, becomes equally parietal, and appears to be equivalent to a nucleus, for it immediately doubles itself, and displays between its two moieties a partition of protoplasm, by means of which the spore, which has become ellipsoid, is divided along its smaller axis, into two equal parts. But this nucleus is so small that we are unable to observe the details of its division. In the partition of protoplasm, there is formed at the same time a new wall of cellulose, which speedily acquires a great thickness. The two small nuclei which generally are at first fixed near the new wall, cannot be distinguished from the other granular contents of the spores, until these acquire a greater age. Finally, the membranes of the spores which have become bicellular, rapidly acquire a colour, which becomes deeper and deeper, from grey to brown. The small quantity of protoplasm which surrounds the spores becomes tinted always, by iodine, of a yellow-brown.

The Blood-globules of different Races of Man.—Dr. J. G. Richardson, of Philadelphia, has sent us an important paper which he has published on this subject in the 'American Journal of Medical Sciences.' He determined to obtain from the several individuals of different parts of the world who went to the American Exhibition last autumn, specimens of their blood. And he thus describes the results:—"The samples were each procured by myself from the individuals mentioned (sometimes only through much persuasion), by puncturing a finger with the quick stab of a cataract needle, pressing out a small amount of blood, applying a clean slide to the apex of the drop, and then spreading out the portion of fluid which adhered to the glass, with the end of another slide, according to Professor Christopher Johnson's excellent method. The measurements were all made with a $\frac{1}{25}$th immersion objective and by the aid of a cobweb micrometer eye-piece, giving when thus combined a power of 1800 diameters. The value of the degrees of the eye-piece micrometer with this objective, at the cover correction employed, was determined by a stage micrometer kindly compared for me by my friend Col. J. J. Woodward, of Washington, D.C., with one carefully tested by the standard in the U.S. Coast Survey Office, and which he has pronounced practically correct. Instead of measuring all corpuscles, deformed or otherwise, in two directions, as proposed by Dr. Woodward,* I prefer to determine the size of unaltered, i.e. circular corpuscles *only*. By this plan, which I believe is that of our highest authority upon the subject, Professor Gulliver, we obtain the dimensions of nearly normal cell elements, such as are exhibited in Dr. Woodward's beautiful photograph of fresh blood,† where, as in fluid preparations, but little variation in size exists among the corpuscles; and escape being misled by pathological specimens similar to those displayed in photograph No. 836, of the same invaluable series. Since the chief cause of marked variation in magnitude as well as of distortion in shape among blood-disks spread out upon glass is, I think, their mutual attraction and repulsion during

* 'Phila. Med. Times,' vol. vi. p. 457.

† 'Army Med. Museum,' No. 861, New Series.

the process of drying, my investigations were made upon portions of slides where the corpuscles were very sparsely disseminated, and then, to secure the most infallible accuracy for my deductions, as the preparation was moved along, I measured *every isolated circular red disk* which came into the field of the microscope. In doing this I cautiously avoided recording those which manifested even slight departures toward an oval form, and by several experiments learned that the deviation corresponding to a transverse diameter of $\frac{1}{3030}$ and a conjugate of $\frac{1}{2857}$ of an inch was recognizable by a single glance. One hundred corpuscles in each specimen were measured and the dimensions as I read them off in millionths of an inch noted down generally by an assistant. These memoranda, with the preparations to which they refer, are carefully preserved for examination by any experts who may desire to convince themselves respecting the substantial foundation of fact whereon I base my conclusions." Here follow the several results, which have been put in a more convenient form by the editor of the 'American Naturalist' (March 1877) than they have in the original paper:

Nationality of Subject.	Age of Subject.	Number of Corpuscles Measured.	Average Diameter of Corpuscles.	Maximum Diameter of Corpuscles.	Minimum Diameter of Corpuscles.	Percentage of Corpuscles less than 1–3448 in Diameter.	Percentage of Corpuscles between 1–3448 and 1–3030 in Diameter.	Percentage of Corpuscles more than 1–3030 in Diameter.
Japanese	..	100	1–3212	1–2777	1–3737	8	82	10
Spanish	30	100	1–3226	1–2777	1–3571	6	89	5
Belgian	38	100	1–3203	1–2777	1–3846	7	88	5
Swiss	40	100	1–3203	1–2857	1–4000	7	82	11
Turkish	29	100	1–3197	1–2777	1–3846	4	80	16
Danish	25	100	1–3257	1–2857	1–4000	12	82	6
Russian	27	100	1–3190	1–2857	1–3571	2	91	7
Norwegian	35	100	1–3252	1–2857	1–4000	10	86	4
Swedish	33	100	1–3254	1–2777	1–3737	13	82	5
Italian	35	100	1–3272	1–2777	1–4000	10	83	7
French	67	100	1–3239	1–2777	1–3737	12	80	8
Dark mulatto, born in U.S.	52	100	1–3229	1–2857	1–3856	11	83	6
Cherokee Indian, born in U.S. ..	48	100	1–3215	1–2857	1–4000	10	83	7
English parentage, born in U.S.	40	100	1–3191	1–2777	1–3846	6	85	9
Total ..	..	1400	1–3224	1–2777	1–4000	8	83	9

"Combining these deductions, we find that of the whole 1400 corpuscles each separately measured, the average was $\frac{1}{3224}$ (·007878 mm.), the maximum $\frac{1}{2777}$, and the minimum $\frac{1}{4000}$ of an inch; 1158 or 83 per cent. measured between $\frac{1}{3448}$ and $\frac{1}{3030}$ of an inch in diameter, and consequently under a power of 200 would appear about

the same magnitude; 118 or about 8 per cent. were less than $\frac{1}{3448}$, and 124 or nearly 9 per cent. were more than $\frac{1}{3030}$ of an inch in diameter. The total number of corpuscles $\frac{1}{4000}$ of an inch across was 6, or less than one-half of 1 per cent. The total number $\frac{1}{2777}$ of an inch in diameter was 10, or less than 1 per cent. The somewhat smaller averages of the Italian, Swedish, and Norwegian specimens are perhaps due to slight accidental variations in spreading out the layers of blood for examination, and cannot be accepted, at least without further research, as indicative of either personal or national peculiarities."

Microscopical Contents of Foreign Journals.

The following brief notices of foreign journals of interest to the microscopist are taken partly from 'Nature' and the 'Journal of Botany' (for March):

Morphologisches Jahrbuch, vol. ii. part 4.—On the Development of the Auriculo-ventricular Valves of the Heart, by A. C. Bernays.—On the Segmentation of the Ovum and Formation of the Blastoderm in Calyptræa, by A. Stecker.—On the Primitive Groove in the Chick, by A. Rauber.

Revue des Sciences Naturelles, vol. v., No. 3, December 1876.—Contributions to the Natural History and Anatomy of the Ephemeridæ, by N. and E. Joly; an important paper.—On Parthenogenesis in *Bombyx mori*, by Carl von Siebold.—On the Histology of the Egg, by A. Villot, dealing with theoretical views on the germinal vesicle and its history.

Bot. Zeitung, January 1877.—H. de Vries, "On the Expansion of Growing Cells from Turgescence."—M. W. Beyernick, "On Plant-galls."

Flora, January.—L. Celakovsky, "On the Morphological Structure of *Vincetoxicum* and *Asclepias*" (tab. 1). — C. Kraus, "On Relations of Turgescence to Growth-phenomena."—A. Batalin, "Mechanism of Movements of Insect-eating Plants."—V. A. Poulsen, "A New Locality for Rosanoff's Crystals."

Œsterr. Bot. Zeitschr.—"On the Occurrence and Origin of Etiolin and Chlorophyll in the Potato."

Bull. Bot. Soc. France, 1873, pt. 3.—E. Mer, "Vegetative Phenomena preceding and accompanying the fall of Leaves."—Ripart, "On New or Rare Cryptogams for Centre of France."—E. Prillieux, "Formation and Development of some Galls."—E. Mer, "Nature and Functions of Evergreen Leaves."—Id., "Effect of Immersion on Aërial Leaves."

Nuovo Giorn. Bot. Ital.—G. Briosi, "On the *Phytoptus* Disease of the Vine" (tab. 1). [This article we have had translated, and reproduced in the present number of the 'M. M. J.']—Id., "On the Function

of Chlorophyll in the Vine."—G. Archangeli, "On a Disease of the Vine" (tab. 3).—G. Cugini, "On the Hairs of Species of *Plantago*" (tab. 4–6).

Zeitschrift für Wissenschaftliche Zoologie, vol. xxvii. part 4, 1876.—On the Anatomy of the Ophiuroid, *Ophiactis virens*, by H. Simroth, seventy pages, five plates.—On the Structure of the Brain in Arthropods, a Memoir describing the brains of *Apis mellifica*, *Gryllus campestris*, *Gryllotalpa vulgaris*, *Carabus viol.*, and *Astacus fluviatilis*, by M. J. Dietl, of Innsbruck, thirty pages, three plates.

Reale Istituto Lombardo di Scienze e Lettere, Rendiconti, vol. x. fasc. 1.—On *Helminthosporium vitis* (Lev.), a Parasite of the Leaves of the Vine, by M. Pirotta.—On the Phenomena which accompany the Expansion of Liquid Drops, by M. Cintolesi.

Ofversigt of the Stockholm Acad. of Sciences, 1876, No. 6.—Dr. Nordstedt and Dr. Wittrock have published a paper in this on the *Desmidiæ* and *Ædogonia* of the Tyrol and Italy. Two excellent plates display the several novelties.

In *Naturforscher* (January 1877) we note the following papers:—On the Germination of the Fruits of Mosses, by P. Magnus.—On the Preparation of Pure Alcohol Yeast, by Moritz Traube.—New Researches on Bacteria, by E. v. M.—On the Exhalation of Carbonic Acid and the Growth of Plants, by L. Rischawi.—Researches on Assimilation in Plants, by A. Stutzer.

The *Memoirs of the St. Petersburg Society of Naturalists*, vol. vii., contains a series of valuable physiological contributions, the most important of which are:—On the Comparative Anatomy and Metamorphology of the Nervous System of the Hymenoptera, by E. K. Brandt.—On Changes in the Eye produced by the Section of the *nervus trigeminus*, by M. Chistoserdoff.—On the Nucleus of the Red Globules of the Blood, by A. F. Brandt.

NOTES AND MEMORANDA.

Death of Dr. Bowerbank.—It is with great regret that we have to announce the death of one of our most distinguished Fellows, J. S. Bowerbank, LL.D., F.R.S., which occurred at his residence at St. Leonards-on-Sea, on March 8, and which we believe was caused by an attack of bronchitis. He had lived beyond the time that is generally allotted to us; that is to say, he had more than completed his threescore and ten years, being in fact eighty at the period of his death. He has not of late communicated anything to the Society, but he was not on that account idle. On the contrary, he was at work almost till his decease. Indeed, it is but a few months since a paper of his on the *Spongiadæ* was read before the Zoological Society. Besides his

various papers on zoology, communicated from time to time to the different associations, the great work by which his name will be remembered is the 'Monograph of the British Spongiadæ,' a book published in 1864 by the Ray Society, and which has been admirably illustrated by Mr. Lens Aldous.

Mr. Bridgman's Mode of Polishing a Speculum. — In a paper published in the February number of the 'Quekett Club,' Mr. Bridgman gave an interesting account of a new universal reflecting illuminator, which we regret that we cannot condense, as without the illustrations our remarks would be unintelligible. However, he also appended some observations on the above subject which are worthy of being recorded here. He says:—Having obtained the silver plate, and had it soft-soldered to a brass back and cut to the size, let a piece of sealing-wax or a small block of thick plate glass be attached to its back as a handle and to prevent flexure. Now procure a common writing-slate with a flat and smooth surface, and grind the silver with water until all scratches have disappeared, and a level face has been produced. If the surface be now well burnished with a straight burnisher it will add greatly to the brilliancy and durability of the polish. Next, take two pieces of thick plate glass, not less than three or four inches square, and upon the surface of one melt some pieces of clean pitch until soft enough to be spread evenly with a hot knife to about the thickness of a sixpence. Let the surface of the other glass be smeared with soap and water, and then pressed upon the soft pitch until the latter shall have acquired a flat and highly polished surface, when it may be *slid off*, and the pitch left to harden. Obtain at the chemist's a pennyworth of "precipitated carbonate of iron" (the softest and finest "rouge" possible), and mix with a few drops of water to the consistence of cream, and let the metal be lightly worked with this over all parts of the pitch in small circles, carefully avoiding all dirt or grit until the polish, commencing in the centre, shall have spread to the edges, and have a deep and brilliant lustre that will reflect objects with the utmost sharpness of definition.

A New Microtome for cutting a series of sections was recently described to the Boston Society of Natural History, by Mr. C. S. Minot. We have not yet seen any description of the instrument.

Mr. Spencer's Objective.—In our last number we described an objective of Mr. Charles A. Spencer, on the authority of the 'Cincinnati Medical Journal.' We now learn from that Journal that the object-glass referred to was not made by the veteran Spencer, but by his son, who, it states, with his father, and brother-in-law, O. T. May, is engaged in the manufacture of microscopes, under the "firm name" of Charles A. Spencer and Sons, in connection with the Geneva Optical Company. The immediate work of making these fine lenses is done by Mr. Herbert R. Spencer. The glass alluded to is a three-system lens, and is of 170° angle of aperture, instead of 160° as stated.

CORRESPONDENCE.

Microscopical Centennial Exhibition.

To the Editor of the 'Monthly Microscopical Journal.'

7, Wigmore Street, Cavendish Square,
February 20, 1877.

Sir,—The January number of the 'Monthly Microscopical Journal' contains a review of the microscopes in the Centennial Exhibition at Philadelphia, in which the writer, Dr. Ward, while giving a most favourable notice of our exhibit, and expressing himself in a handsome manner as to the style and finish of our instruments, makes a remark which we fear may possibly bear a wrong interpretation. Referring to our objectives on Wenham's new formula, Dr. Ward states that they were "understood to have been entered for competition and then permanently removed from the Exhibition and the country." This would imply that they were taken away *before being examined*, but this was *not* the case, as the judges tested the whole series critically on several occasions, and it was not until they informed our representative that their examinations were completed that the glasses were removed from the building. We may add, that the judge's Report is now in our possession, and that it is highly commendatory to both our microscopes and new objectives.

We are, Sir, yours obediently,

Ross and Co.

On the means of Centring Objectives and Rotating Stages.

To the Editor of the 'Monthly Microscopical Journal.'

February 28, 1877.

Sir,—All who work with high powers, and use high-angled achromatic condensers, have, no doubt, felt the inconvenience of the concentric rotating stage being *eccentric*, not only with different objectives, but even, very often, with the one to which it may have been adjusted; and they may also have observed that the achromatic condenser, notwithstanding that it may have been carefully centred, will sometimes become eccentric.

These defects are, of course, much less apparent in the *very best* workmanship.

The means of "accurately centring the stage to the highest power objective" was introduced in 1875,* and later in the same year † the "concentric rotating stage having rectangular mechanical adjustments" was brought before the Royal Microscopical Society. Both these plans are based on nearly the same principle, and the result aimed at is to render the rotation of the stage concentric with any

* 'Science-Gossip,' September 1875, p. lxvii.; and 'M. M. J.' No. lxxxi. September 1875 (cover).

† 'M. M. J.' No. lxxxv. p. 54, January 1876.

objective that the observer may wish to employ. But neither plan is of any use for centring objectives to the achromatic condenser when it is eccentric; moreover, the above adjustments are cumbersome, because they must be *fixtures*, and their use is limited.

The "new centring nose-piece" is, in my opinion, a great boon to observers who work with high powers on *test* objects. Test work may not be very instructive, but it is undoubtedly the cause of the great improvements made on some of the modern objectives; it is also fashionable, not only among *amateurs*, but even among *savants;* and therefore any new apparatus that facilitates the attainment of accuracy should be welcomed.

The centring nose-piece is made by Mr. Swift, and it figures in 'Science-Gossip' for February, page xv. The rectangular adjustments act in the same manner as those of the sub-stage, and the objective is thereby adjusted to the optical axis of the instrument. This nose-piece has the following advantages, namely: 1st, it is *not* a fixture, and it works with any microscope fitted with the "universal screw": 2nd, it may be used to rectify the eccentricity of the achromatic condenser caused either by the "spring" of the fine adjustment when moving the screw-collar of the objective, or by the unsteadiness of the sub-stage; and also to centre any objective to the achromatic condenser fitted to a microscope without any under-stage adjustments: 3rd, it may also be used to render the rotating stage concentric with any objective. The only drawback is that this nose-piece may slightly strain the fine adjustment.

It must be taken into consideration that neither the centring of the stage, nor that of the objective, is obtained "instantaneously" nor "with the greatest facility": in either case the adjustments *must be made very carefully.*

I am, Sir, yours obediently,

A. de Souza Guimaraens.

Note on the Structure of the Test in Arcella.

To the Editor of the 'Monthly Microscopical Journal.'

Sir,—In the 'Quarterly Journal of Microscopical Science' for January last, p. 79, the following statement appeared:

"For the first time seemingly a correct description of the structure of the peculiar test of the somewhat variously and otherwise pretty well known and at least common species *Arcella vulgaris* (Ehr.), is given by Hertwig and Lesser. Two plates, an outer forming the superficies of the test, an inner applied to the body of *Arcella*, are united in a honeycomb-like structure, whose hexagonal cavities form prismatic spaces standing vertically on the surface. Hertwig and Lesser conclude that the appearance of the markings on the *Arcella* test is not due to granulation as Dujardin supposed, or Claparède and Lackmann as well as Carter assumed. Wallich indeed spoke of symmetrical reticulation and of hexagonal interspaces; still Hertwig and Lesser doubt if he altogether correctly appreciated the structure,

as how otherwise could he come to the conclusion that *Arcella vulgaris* could be but a sub species or even a species of Difflugia?"

What on earth my conclusions regarding the limitation of species in these lower forms of animal life have to do with the correctness or incorrectness of my published description and figures of the structure of the Arcelline test I am at a loss to conceive. The one is a matter of opinion; the other a matter of fact. I am quite ready, however, to allow that in my humble opinion our knowledge of the biological relations of the Protozoa and Protophyta is much more likely to be increased by taking into due consideration the causes on which divergence is mainly dependent, than by seizing upon every trivial variation from an assumed type as evidence of specific distinctness.

How far it is admissible to say that "a correct description" of the structure of the test of *Arcella* was given "for the first time" by Messrs. Hertwig and Lesser," and that I merely "spoke of symmetrical reticulation and hexagonal interspaces," the subjoined extract will at once show. I may mention that it is taken from the explanatory references which accompany the plates illustrating my memoir 'On the Extent and Causes of Structural Variation among the Difflugian Rhizopods;' and that a detailed figure is there furnished of the structure as it exists in *Arcella*.

"Fig. 37. Front view of *D. arcella*. Fig. *a* shows *the invariably hexagonal pitting or reticulation of D. arcella* (*Arcella vulgaris*). This can only be made out, however, in a mounted and crushed test, under a high power." *

I remain, Sir, your obedient servant,

G. C. Wallich, M.D., &c.

PROCEEDINGS OF SOCIETIES.

Royal Microscopical Society.

King's College, *March* 7, 1877.

H. C. Sorby, Esq., F.R.S., President, in the chair.

The minutes of the preceding meeting were read and confirmed.

A list of donations to the Society since the previous meeting was read by the Secretary, and the thanks of the Society were voted to the donors.

The President had great pleasure in announcing that there was every reason to believe that arrangements would be made with Sir John Lubbock to deliver the first Quekett lecture to the Society on May 2. The subject would in all probability be "The Microscopic Characters of Ants in connection with their Habits and Instincts." The Quekett medal, which had recently been struck for the purpose, would be presented to Sir John Lubbock at the close of the lecture.

* 'Annals and Mag. Nat. Hist.' March 1864. Explanation to plate xvi. fig. 37.

Tickets would be issued to the Fellows for the admission of themselves and one friend, and the use of the large theatre of the College had been obtained for the purpose. He added, the Council had arranged to have another scientific evening meeting on Wednesday, April 18, of which due notice would be given.

The Secretary read a letter which had been received from Mr. Frederick Ebsworth, of Australia, describing a method of estimating and recording the dimensions of small objects, or the fineness of wool. An explanatory diagram accompanied the letter.

The thanks of the meeting were voted to the writer for his communication.

A paper by the Rev. W. H. Dallinger was read by the Secretary, entitled "Additional Note on the Identity of *Navicula crassinervis*, *Navicula rhomboides*, and *Frustulia Saxonica*." (The paper will be found at p. 173.)

The President, in proposing a vote of thanks to Mr. Dallinger, said that the subject was one to which he had himself paid little or no attention, and therefore it would be out of place for him to say anything about it; but he thought it must be plain to everybody present that the method adopted by Mr. Dallinger could not fail to be the right one. He was sure that they would all be very glad to hear that Mr. Dallinger was about to receive considerable help in making his very interesting and important investigations—the sum of 100*l.* having been voted to him by the Royal Society from the Government Grant Fund of 4000*l.* in order to further the progress of the observations upon which he was engaged.

A vote of thanks to the Rev. W. H. Dallinger for his paper was unanimously carried.

Mr. Ingpen said he was hardly in a position at a moment's notice to make remarks upon the subject of the paper which were of sufficient value to be worth their attention. The points of his former observations were directed to the use that should be made of generic names rather than to the identity or otherwise of the forms themselves, and the question of making use of one name for a large number of apparently different forms. He could not help fancying, however, that in a certain group there were collected together a number of diatoms in which, although there was the same arrangement of markings, and therefore a good generic character, there were differences in other respects, and that these differences had been made use of for purposes which were not legitimate. For instance, the Rhomboides was put forward by one maker as a test for a particular objective, and another maker would produce a glass which would resolve a coarser form, also called Rhomboides. This would not be a fair test. He quite agreed with Mr. Dallinger that out of a great number of slides it was possible to find every intermediate variety between two forms, but what they really wanted was the establishment of something like type species. In the case before them they had three distinct forms and many varieties between them, and he quite agreed that the generic term of *Frustulia* was totally unnecessary. Yet which were they to take as their type form—as a test? He thought they had

something like a starting point in the original *Navicula rhomboides*—they had its shape, its markings, and its median line, it was figured in "Smith," and would be a very good one to start from. Then in the same book they had also *N. crassinervis*, or *crassinervia*, which had distinctly different ends, was round at the sides, and had the ends of the median line terminating in distinct nodules, compared with which *N. rhomboides* had its sides straighter, was more generally rhomboidal, and its median line terminated in blunted lancet-shaped points. Between these two they could easily get every variation leading from one to the other, and he thought it was most important from amongst these varieties to get a well-established typical Rhomboides and a typical Crassinervis. What had happened was that for some time they had one form only, after that a coarser form was brought forward as a test for a $\frac{1}{4}$ inch; it was much rounder at the sides, and there was a difference in the centre and ends of its median line, which were flattened and battledore-shaped; and then after this they got another form from the Cherryfield diatoms. On the same slide they might see the original Rhomboides and the new specimen. He thought that in this respect Möller had done a great deal towards creating this confusion, for on his type slide they found Rhomboides; but it was the big form, and nothing at all like the Rhomboides of Smith, whilst next to it was what he called Crassinervis—exactly the same as the original Rhomboides, but nothing at all like the Crassinervia of Smith. He should be one of the last to increase the number of genera and species upon insufficient data, but thought they ought not to group together forms which differed so greatly from the type given as that of the species. They wanted at least to know what they were talking about, instead of getting one so mixed up with another that as test-objects they might be used for what might be called illegitimate purposes and so became of little value.

Mr. Slack said the paper raised a very wide practical question, and one which was not confined to diatoms. When a botanist was able to show that certain extreme forms were connected by a series of intermediate gradations, he was justified in placing them together in the same group notwithstanding their differences, just as a greyhound and a bulldog were both classed as dogs. In order to know what they were talking about, where there were a great number of so-called species in the question, it was well to retain distinctive names for them for purposes of identity even long after it had been shown that they had no claim to be spoken of as belonging to different genera or species.

Mr. Charles Brooke said it appeared to him as a general question that it was quite impossible to assign two individuals to different genera when there was a series of intermediate forms which might be found passing from one to the other. It might be desirable to know the various forms by different names—as in the case of dogs already mentioned—but they should not be known as distinct species, and this should never be done where such gradations existed. This gradation of form had been traced throughout the whole class of the Foraminifera to a far greater extent than amongst the diatoms, and amongst

them they found immense differences out of all proportion to those of the diatoms, but all unquestionably belonging to the same species, and amongst which it would be impossible to draw any lines if they tried to make them into distinct species.

The President said the subject was one which certainly was not confined merely to diatoms, but which equally belonged to every department of science, only that it happened in the case of diatoms that they had the opportunity of examining so great a number of individuals that the variety would be in a measure proportionately great.

Donations to the Library and Cabinet since February 7, 1877:

	From
Nature. Weekly	*The Editor.*
Athenæum. Weekly	*Ditto.*
Society of Arts Journal. Weekly	*Society.*
Quarterly Journal of the Geological Society	*Ditto.*
Bulletin de la Société Botanique de France	*Ditto.*
Enumeracion de los Vertebra dos Fosiles de España. Par Don C. Calderon, 1877	*Author.*
Journal of the Quekett Club. No. 33	*Club.*
Micro-photographs from the Diatomaceæ. By J. Redmayne ..	*Author.*
Some Remarkable Forms of Animal Life from the Great Deeps off the Norwegian Coast. Part 2. By George O. Sars	*Ditto.*
On the Practical Application of Autography in Zoology, and on a New Autographic Method. By G. O. Sars	*Ditto.*
Eleven Stained Preparations, &c., prepared by Dr. Christopher Johnstone, of Baltimore	*Ditto.*
Twelve Slides of whole Insects	*F. Enock, Esq.*

G. H. Jones, Esq., was elected a Fellow of the Society.

WALTER W. REEVES,
Assist.-Secretary.

MEDICAL MICROSCOPICAL SOCIETY.

February 16, 1877.—Henry Power, Esq., President, in the chair.

Hyperœmia of the Brain from Hanging.—Dr. Browning exhibited some interesting specimens illustrative of this subject. Two were taken from executed criminals, and were prepared by Surgeon-Major Roth, of Berlin, and one was from one of the lower animals that had been hanged for experiment. The brains were, in all cases, injected with carmine. In his remarks upon these specimens Dr. Browning stated that whereas most medico-legal writers describe only a medium amount of vascularity in the brain and that of venous character, and extravasations as very rare, he had found the congestion most intense: the capillaries being so distended in some parts that scarcely any nerve substance was to be seen: however, he had not found any extravasations of blood. As cause for the vascularity, the speaker suggested that the knowledge of his fate might, in the case of the criminal, cause some hyperœmia at last, though this could not hold with the lower animals.

The cerebellum he had found more vascular than the cerebrum.

The President suggested that the vascularity was owing to pressure

on the veins, while the arteries could, from not being so compressed, still force up more blood. He thought that the knowledge of his fate would rather make the criminal's brain anæmic than hyperæmic. The lower part of the spinal cord was undoubtedly congested, as shown by the frequency of priapism in these cases.

After some further remarks from various members, the meeting resolved itself into a conversazione to examine the specimens.

Liverpool Microscopical Society.

The annual meeting of this Society was held on Friday, January 19, at the Royal Institution, the Rev. H. H. Higgins, M.A., in the chair. The annual report of the Committee stated that the number of members on the books of the Society was much the same as last year, and that the financial position of the Society was satisfactory. Important donations have been made of valuable slides to the Society's cabinet during the session; and also a further number of books have been added by donations and purchase to the library.

The Committee congratulated the Society on the fact of the President, the Rev. H. H. Higgins, having consented to retain the office of president for another year, in consequence of his prolonged absence, occasioned by his having, on the nomination of the Library, Museum, and Arts Committee of the Town Council, joined the 'Argo' scientific expedition to the West Indies, which has resulted in some very valuable additions to our local collections.

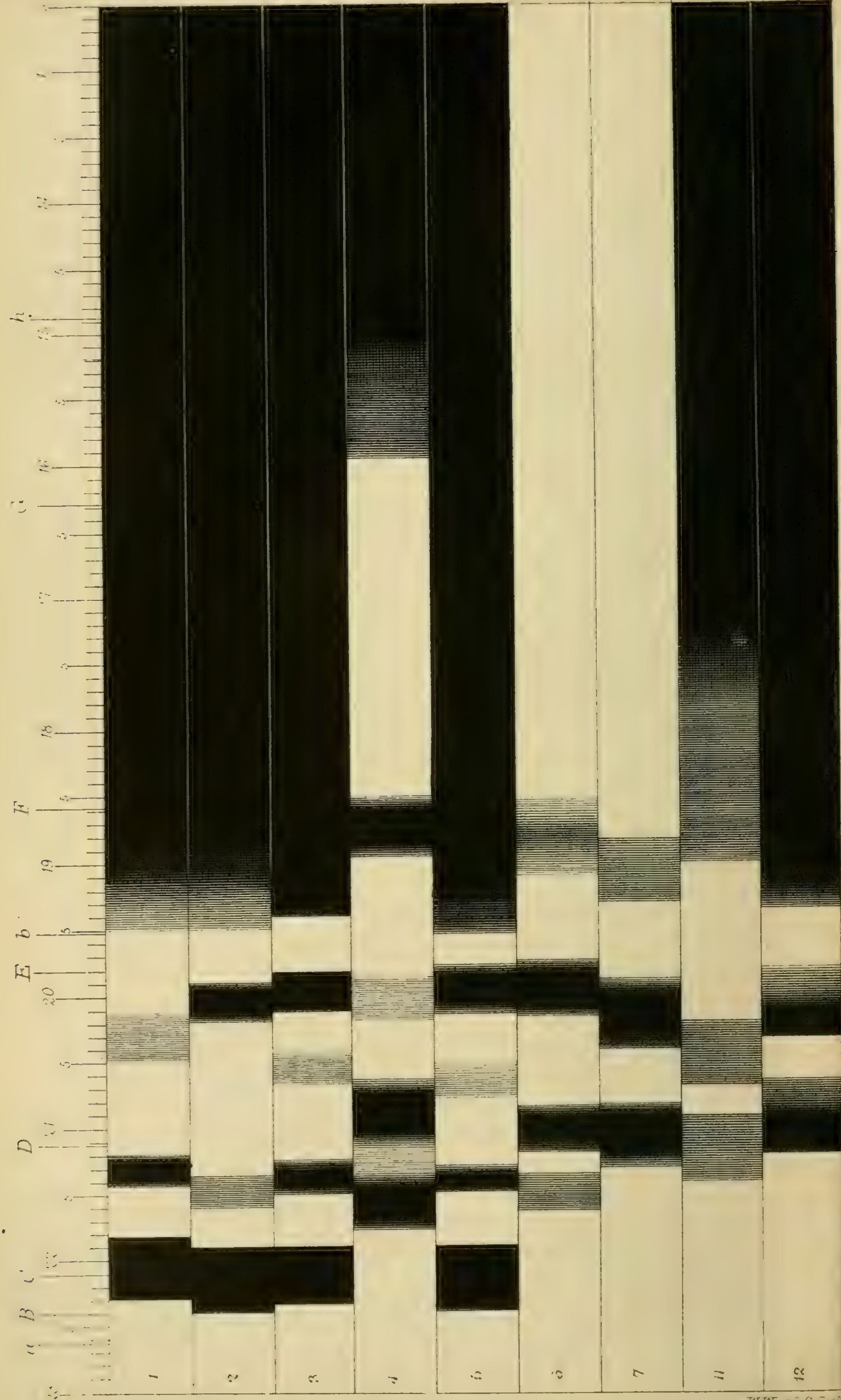
The President delivered his inaugural address. In the course of it he said: Your kind reception of my paper on "Lines of Animal Life," consisting chiefly of remarks on the Stammbaum des Thierreichs of Professor Koch, induces me to hope that a similar attempt to illustrate the vegetable kingdom may be acceptable, and the subject of my address this evening is "Lines of Vegetable Life."

Thanking you for the favour of occupying during the second year the honourable position which I hold as your President, my best apology for so very brief a preface may be the interest and magnitude of my subject." In concluding the address, the President said: "To appreciate these facts in nature it is not necessary to regard the theory of evolution as if evolution were unconditioned or of universal application; at the same time it must, I think, be admitted that in the absence of that theory the facts themselves would be incomprehensible, or would possess comparatively little interest."

The second ordinary meeting of the ninth session was held on Friday, February 2, at the Royal Institution, Colquett Street; the Rev. H. H. Higgins, M.A., President, in the chair. The Hon. Sec. (Mr. Chantrell), in announcing the donations, read a letter he had received from Mr. G. B. Rothera, of Nottingham, who was present as a visitor at the annual meeting, and heard the President's inaugural address, the subject of which was "Lines of Vegetable Life." To show his appreciation of the address, and his desire to see it published, he enclosed 5*l.* as a donation to the Society's funds. Mr.

Joseph Birdsale Jones and Dr. J. Birkbeck Nevins were elected ordinary members.

The Rev. W. H. Dallinger, F.R.M.S., gave a practical "Note on the Ultimate Limit of Vision," as applied to our modern microscopical lenses. Reasoning on certain data more or less theoretical, mathematicians of the first order, notably Helmholtz, had concluded that the limit of vision had been reached; that the optician could practically aid us no further; that, in short, the limits of possibility had been arrived at, since light itself is too coarse to reveal objects smaller than those visible to our finest and most powerful lenses. The limit marked out was about the one hundred and eighty thousandth of an inch. But Mr. Dallinger gave instances of a remarkable kind—the result of his personal investigation—directed specially to this point, which were proved by a method of measurement employed specially for the purpose to carry the power of our most delicately constructed lenses considerably further than the mathematician considered possible; revealing, indeed, smaller objects than those mathematically indicated; and Mr. Dallinger did not by any means believe that he had wholly exhausted the utmost power of visibility by these experiments. A discussion followed, which was chiefly concerned in eliciting more in detail the method employed in these delicate measurements. The meeting concluded with the usual conversazione, at which there was a good display of microscopes and many interesting objects exhibited.



W. West & Co. lith.

THE

MONTHLY MICROSCOPICAL JOURNAL.

MAY 1, 1877.

I.—*The various Changes caused on the Spectrum by different Vegetable Colouring Matters.* By Thos. Palmer, B.Sc.

(*Read before the* Royal Microscopical Society, *April* 4, 1877.)

Plate CLXXIX.

The kind reception that I met at your hands on a former occasion has encouraged me to trespass this evening for a short time on your forbearance, while I lay before you the result of some observations that I have lately been making on the variability of the chlorophyll band in the spectrum.

Chlorophyll, *Fæcula viridis*, or leaf green, is the name generally given to the green colouring matter of vegetables; it is found in nearly all plants growing in the light, with the exception of fungi and the true parasites, covering either the cell-walls or the spiral bands, as in Spirogyra, or the granular contents of the cells, which are composed of starch, or other similar bodies. If plants that have been grown in the light are placed in the dark, the leaves fall; and if others are produced, they have a whitish colour: again, if the plants that have been thus grown in the dark are removed to the light, the leaves soon lose their white hue, and eventually assume their natural colour; the rapidity with which they become green, and the intensity of their colour, will be in proportion to the amount of light to which they are exposed. The different rays of the spectrum have a varying influence in promoting the formation of chlorophyll, and some difference of opinion exists as to which rays are the most active in this respect, but the majority of experimenters agree that the yellow rays are those which are the most essential, because they have the greatest effect in promoting the decomposition of carbonic acid.

EXPLANATION OF PLATE CLXXIX.

Fig. 1.—Chlorophyll normal.
„ 2.—Chlorophyll acid.
„ 3.—Leaves of Lobelia.
„ 4.—Petals of blue Cineraria.
„ 5.—Leaves of Shumac.
„ 6.—Tradescantia.
Fig. 7.—Petals of red Cineraria.
„ 8., „ 9., „ 10. } Litmus. (Figs. in text.)
„ 11.—Hypericene normal.
„ 12.—Hypericene acid.

Note.—Class 1 is a symmetrical band. Class 2 is an unsymmetrical band.

Mr. Fremy investigated the nature of this agent, and has ascertained that it is composed of two colouring principles, one a yellow, the other a blue; the former he has called phylloxanthin, and the latter phyllocyanin. Both these principles have been isolated by Mr. Fremy, who has also endeavoured to show that the yellow colour of blanched and very young leaves is due to the presence of a body which he has termed phylloxanthein, and which is coloured blue by the vapour of acids. The same result occurs in the discoloration of phyllocyanin; hence it would seem that this phyllocyanin is not an immediate principle, but that it is formed by the alteration of phylloxanthein, and indeed the spectroscopic observations that have of late years been carried on in relation to this subject, I am sure I may say by Mr. Sorby, tend to show that chlorophyll is more complex than Mr. Fremy considered, as the substances he treats of were probably only products of decomposition by acids.

The various shades of green seen in the organs of plants depend upon very different causes; partly upon the nature of the chlorophyll, whether it is pure, or more or less mixed with the yellow, blue, or brown products of its decomposition—see Mr. Sorby's paper "On the Colours of Leaves at different Seasons of the Year;" partly upon the quantity of chlorophyll in the individual cells, partly on the thicker or looser arrangement of those cells, as on the under sides of leaves, which are generally of a lighter green, depending on the intercellular spaces which are there present, and which reflecting the light, white, thus mix with and diminish the intensity of the green.

When any form of chlorophyll is treated with ether or alcohol, the colour is abstracted, while the organized forms, the corpuscles, &c., remain, so that true chlorophyll is really only a soluble substance, dyeing the bodies called chlorophyll granules, &c.; but the various degrees of solubility depend greatly on the presence of other substances, for instance, in the case of such evergreens as laurel, ether takes hardly any effect, but alcohol thoroughly discolours the leaves, whilst pyrethrum, a perennial, is hardly acted upon at all by alcohol, but ether takes great effect.

If these solutions are evaporated to dryness, under the exhausted receiver of an air-pump, a green fatty matter is left, which forms soaps in combination with the alkalies. If this is again dissolved in ether, and mixed with water, and the ether evaporated, small greasy globules are obtained, and similar globules are separated from the alcoholic solution at a freezing temperature. If the alcoholic tincture be mixed with water, and the alcohol evaporated by heat, part of the fatty substance is precipitated; the remaining solution is coloured a brown yellow, and has a characteristic smell, like that of black tea. It is soluble in the volatile and fixed oils,

but when treated with sulphuric acid it is either not changed or else carbonized.

With regard to the second point or the colouring matter of plants, the green colour, which forms the most extensive class, has been treated upon in our primary consideration on chlorophyll; the red and yellow colours, as assumed by the leaves in autumn, are due to a chemical metamorphosis of the chlorophyll, and consequently the discoloration of the cellular tissue: see also Mr. Sorby's paper "On the Various Tints of Autumnal Foliage."* But independent of all this, there are the colours of the red cabbage, copper beech, and similar plants, all of which depend upon the existence of a special colouring liquid in the usually colourless epidermal cells, obscuring the chlorophyll which lies beneath. The bright colours of plants, and other parts of the inflorescence, as also on the lower surface of many leaves, *Begoniæ Victoriæ*, for instance, as well as numerous herbaceous shoots, arise from the presence of matters of a different kind, almost always dissolved in the watery cell-sap. The colour of petals is ordinarily found to depend upon a certain number of the cells subjacent to the epidermal layer being filled with a coloured fluid, and the depth of the colour is proportionate to the number of superimposed layers of such cells, which act like so many layers of a pigment: each cell is usually filled with one colour when fully developed, but adjacent cells are often seen in variegated petals to contain distinct colours, the line of demarcation being accurately fixed by the cell-walls, through which the colours do not transude unless injured by pressure. In young tissues the colour has often a granular appearance in the cells, but this is a deception, arising from the mode in which it is developed. The colourless protoplasm, originally filling the cells, becomes excavated as it were by water bubbles, and the watery contents of the excavations become coloured; they gradually enlarge, as the protoplasm applies itself more completely to the walls of the cell, until they become confluent, and the coloured liquid fills the whole cell-cavity. The isolation of the coloured juice in each particular cell seems to depend upon the primordial utricle, or parietal layer of protoplasm; when this is injured by pressure or other external causes, endosmose is set up, and the integrity of the cell destroyed. In some cases the liquid colouring matter of flowers has been found to contain solid corpuscles; the red-colour cells of *Salvia splendens* and the blue ones of *Strelitzia regina* contain globules, and according to Von Mohl this is still more commonly the case with the yellow colours. In the yellow, perigonal leaves of *Strelitzia regina*, the colour is said to depend on the presence of crescentic filaments, floating in the cell-sap; the white patches also on variegated and spotted leaves, such as those of Aucuba, Holly,

* 'Quart. Journal Sc.' vol. i. p. 64.

variegated mint, Begonia, *Argyro stigma*, &c., arise from the absence of chlorophyll in the cells subjacent to the epidermis at those parts, which produces the same effect as we see in leaves that have been mined by caterpillars.

Now it follows that the colouring agent which is found in vegetables is in several states of combination; *first, with the extractive principle; secondly, with the resinous principle;* and *thirdly, with a starchy or gummy principle*, and it is these states which indicate the means of extracting them.

Firstly, when, as in the case of logwood, madder, &c., the receptacle of the colour is of the nature of extracts, water is capable of dissolving it.

Secondly, certain of the resinous colouring matters are soluble in alcohol, spirits of wine, or ether, and form in many cases the pharmaceutical tinctures: the other principle will be left, as it is hardly in connection with our subject.

We will take as a standard the two solutions of chlorophyll, viz. that in oil normal, and that also in oil acid.

In chlorophyll No. 1 we have a spectrum made up of four bands, two of which are definite, and one shaded, while the other is a general absorption of the blue end. Compared with this, we have chlorophyll No. 2, or that to which a small quantity of acid has been added; we find on examination that a general displacement towards the blue end has taken place, which result, as shown by Mr. Sorby,* is due to a true decomposition of the original substance, obtained when acid is added,† though it is not regained when the acid is neutralized, as the normal action has gone too far for subsequent recovery; a material transformation has, however, taken place in the whole spectrum, the bands are constant though displaced, while their ratios are almost identical; this will be more clearly seen on reference to Fig. 2.

We deduce that the acid has transformed an original substance, which had the power of absorbing the rays of light, beyond λ 652·0; still another band is produced at λ 662·0, and though the bands 2 and 3 are proportionately shifted towards the blue, and have likewise gained in intensity, the general absorption is constant, and has sustained no apparent change: does it not appear possible that, in the case of solutions containing more acidity, this general absorption might be carried still farther into the blue, as, for instance, in other of the colouring agents of plants? and if so, then in the event of an alkaloid form being also present in combination, the same spectrum as Fig. 2 may be still maintained, while the general absorption, &c., will be more nearly approached

* 'Roy. Micro. Jour.' vol. xiii.

† See Mr. Sorby's paper "On Comparative Vegetable Chromatology," 'Royal Society Proceedings,' vol, xxi. p. 456,

towards the red: take, for example, two vegetable colouring matter spectra; first, leaves of Lobelia; secondly, petals of blue Cineraria, for which I must refer you to Figs. 3 and 4.

FIG. 1.—CHLOROPHYLL IN OIL NORMAL.

	M.		λ.	Observations.
1	23·955	Centre	652·0	Class 1. Very black; size ·510.
2	22·700	"	598·5	" 1. Centre dark, ends shaded; size ·200.
3	21·700	"	547·25	" 1. Very shaded; size ·400.
4	20·500	Commencement	515·5	Shaded at first, terminating in a very black absorption.

FIG. 2.—CHLOROPHYLL IN OIL ACID.

1	23·85	Centre	662·0	Class 1. Very black; size ·5.
2	22·55	"	608·5	" 1. Shaded; size ·3.
3	21·95	"	537·0	" 1. Black; ends shaded; size ·3.
4	20·5	Commencement	515·5	Shaded at first, terminating in a very black absorption.

Condition.	λ.	λ.	λ.	Ratio.
In oil	652·0	598·5	547·25	1 : ·9161
" acid ..	662·0	608·0	537·0	1 : ·9188

FIG. 3.—LEAVES OF LOBELIA IN ETHER.

	M.		λ.	Observations.
1	23·892	Centre	658·0	Class 1. Very black; size ·415.
2	22·650	"	601·0	" 1. Centre dark, ends shaded; size ·3.
3	21·450	"	559·0	" 1. Very shaded; size ·3.
4	20·050	"	532·0	" 1. Black; size ·3.
5	20·6	Commencement	512·0	Very black; general absorption.

FIG. 4.—BLUE CINERARIA IN OIL.

1	22·44	Centre	615·0	Class 1. Centre dark, shaded at ends; size ·435.
2	21·135	"	575·0	" 1. Centre dark, shaded at ends; size ·630.
3	20·0	"	535·0	" 1. Very shady; size ·4.
4	19·25	"	490·0	Same as No. 1; size ·5.
5	16·0	Commencement	426·0	General absorption.

In the former specimen, which is prepared in ether, we have almost a facsimile of Fig. 2, though band No. 4 has disappeared; where it began however, a general absorption is evident, bands 1 and 2 are brought nearer the blue end, while No. 3 is farther from it. The spectrum from the petals of blue Cineraria, Fig. 4, is perhaps more striking, as the bands are all nearer the blue end, while their symmetry with the preceding spectra is considerably altered, still owing, no doubt, to the presence of an acid, though comparison is hardly admissible, as the former specimens are prepared from the green leaves, while the latter is extracted from the blue petals of the flower.

We will now pass on to consider the spectrum of Shumac. This substance contains a considerable percentage of tannic acid; Mulligan and Downing give 24·37 per cent. Having procured some of the leaves of this plant from Palermo, I pulverized them, and after due preparation the following solution in oil was the result; the spectrum, which will be seen on reference to Fig. 5, is curious enough to attract our notice, inasmuch as it almost agrees with Fig. 2, though the bands are all more or less nearer the blue end, yet the general absorption is increased towards the red. In this case we have a distinct proof of an existing acid in connection with the fluid; still there are differences, though to a less extent than in the previously considered specimens; may we not assume from this that the chlorophyll in the case of specimens Nos. 3 and 5 is in combination with some alkaline base, while the colour which is predominant in the case of No. 4, is of an acid construction? At the same time I must acknowledge there is every reason to think that an alkaline form is also present, though to a much less extent. It must, however, be borne in mind that this solution of Shumac is prepared from the dried leaves, and therefore I doubt whether the spectrum from living leaves would not be rather different from the one I have brought before your notice.

Fig. 5.—Shumac.

	M.		λ.	Observations.
1	23·857	Centre	661·0	Class 1. Very black; size ·485.
2	22·60	„	605·0	„ 1. Centre shaded, ends very shaded; size ·20.
3	21·35	„	563·5	„ 1. Indistinct; size ·3.
4	20·005	„	535·0	Same as band No. 2; size ·33.
5	20·465	Commencement	517·0	Very black; general absorption.

But before leaving a subject which appears of some importance, there is one more solution, that of Tradescantia, Fig. 6, which is well worthy of our attention, as I think it bears especially on a

point which I wish to make quite clear. You will notice in this instance that band No. 1 is considerably more shaded than those hitherto mentioned, besides being nearer the blue end; this same effect occurs with bands Nos. 2 and 3, but unlike the other spectra they are dark and well defined, though of Class 2, or unsymmetrical, their terminations towards the blue being shaded.

Fig. 6.—Tradescantia.

	M.		λ.	Observations.
1	22·5	Centre	611·0	Class 1. Shaded; size ·3.
2	21·175	"	573·0	" 2. Black, shaded to the left; size ·7.
3	20·05	"	532·0	" 2. Same as No. 2, though lighter; size ·5.
4	19·2	"	491·5	" 1. Shaded as No. 1, centre darker; size ·6.

Band No. 4 will be seen to agree with the corresponding one in Fig. 4, while the general absorption, which we have noticed forms so characteristic a feature in all the previous spectra, is entirely absent. Now it is just this fact which appears to me so curious, for here we have a spectrum which, if I may use the term, includes the whole of the other spectra, and yet it is so different, though to an extent it is accounted for I think, when considered in connection with blue Cineraria, another part also of the inflorescence, in which the chlorophyll is only disseminated in a small degree, as compared with the leaves, &c.: then, with regard to the comparison of blue Cineraria, Tradescantia is certainly more astringent, but time and experience alone will answer these questions, and we will now pass on to consider the second part of my subject.

Part II.

You will doubtless have perceived that hitherto I have only taken those forms of plants which have some similarity to the chlorophyll itself; we will now proceed to consider briefly the totally different colours, such as red and yellow.

First we have red Cineraria, which for the sake of comparison is prepared in the same way as the blue, and it is to this latter, as compared with the former, that I wish to call your special attention. The spectrum, as will be seen on reference to Fig. 7, differs from Fig. 4 in a notable degree; but as most present, no doubt, recollect the inference our worthy President, in vol. xiii. of our researches, drew between this colouring matter and that of *Lobelia speciosa*, I need hardly pursue my investigation further, as the change here is almost identical, though the general absorption,

which to a degree is evident in the blue specimen, is entirely wanting in the red. I annex the ratios of Mr. Sorby's two readings and my own, to show how nearly they agree, and Mr. Sorby has since told me that his specimens were dissolved in a strong solution of sugar, which quite accounts for the slight displacement I have recorded.

Fig. 7.—Red Cineraria.

	M.		λ.	Observations.
1	22·95	Centre	585·	Class 1. Ends shaded, centre dark; size ·5.
2	21·86	„	541·	„ 1. Same as No. 1; size ·465.
3	20·95	„	499·	„ 1. Shaded evenly; size ·455.

Condition.	λ.	λ.	λ.	λ.	Ratio.
Blue Cineraria ..	615·	575·	535·	490·1	1 : ·9263
Red „ ..	585·	541·	499·	..	1 : ·9234
„ „ ..	594·	550·	509·	..	1 : ·9258
Lobelia speciosa	619·	573·	529·	..	1 : ·9257

There may, I think, be found in this alteration of colour some similarity to the chemical effect caused in litmus, when that substance has, through the intervention of an acid or alkali, been turned red or blue, as the case may be; and perhaps I may be permitted to add that I have employed the spectroscope in many cases where the determination of an acid or alkaline base has been necessary in chemical analysis. A glance at Figs. 8, 9, and 10 will suffice to show what takes place when the litmus is no more alkaline or acid, as the case may be: the moment at which the change occurs is the saturating point, and it is at times extremely curious to observe the sort of conflict which takes place between the two agents, till, when subsidence occurs, we have either a normal, acid, or alkaline result; the only point necessary is, that the original solution of litmus be made of a definite strength, and must naturally represent the normal state; that employed in these experiments is of 1 per cent.

Now this seems to imply that the red colour of a fresh plant is more especially acid than the blue; still the conditions of variation are so exceedingly numerous, that to fix anything like a definite why or wherefore as to the cause is quite out of the question, at least so far as my own short experience of nature and natural selection is concerned, I therefore must be pardoned if I shade myself under the following extract, taken from Mr. Darwin's admirable work, entitled 'The Origin of Species.' He there says: "When a variation is of the slightest use to any being, we cannot

tell how much to attribute to the accumulative action of natural selection, and how much to the definite action of the conditions of life." But to pursue the point somewhat further, and still to keep to our author, Mr. Darwin, in his new work, under the heading of "Uniform colour of the flowers on plants self-fertilized,

Fig. 8. Litmus normal.

Fig. 9. Litmus acid.

Fig. 10. Litmus lkaline.

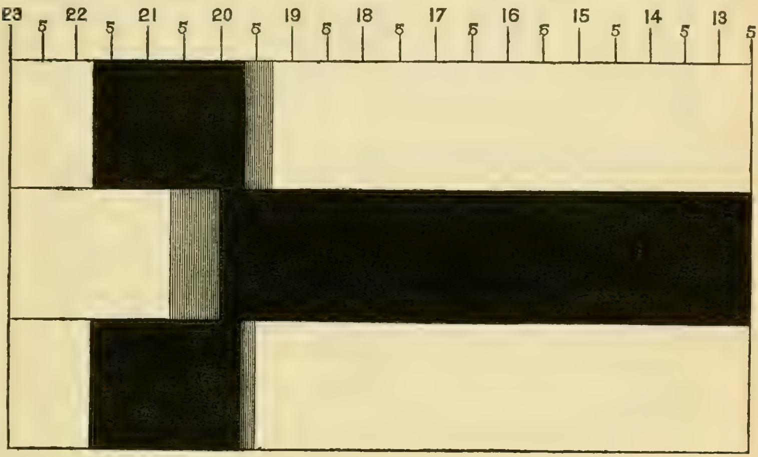


Fig. 8.—Litmus Normal.

M.		λ.	Observations.
21·3	Centre	565·5	Class 2. Very black.
20·7	End	509·0	Shaded to this point; size 2·5.

Fig. 9.—Litmus Acid.

M.		λ.	Observations.
21·2	Commencement	571·0	Shaded gradually to very black, general absorption of blue, &c.
20·0	" "	535·0	

Fig. 10.—Litmus Alkaline.

M.		λ.	Observations.
21·22	Centre	570·0	Same as in Fig. 8; size 2·25.
20·4	End	519·0	

and grown under similar conditions for several generations." Time will not, however, permit me to give you his exact words, but I should strongly advise all my hearers to invest in that charming book, which has now been out for some time, and is entitled 'Cross and Self Fertilization of Plants.' Mr. Darwin, after having

quoted a few cases of experiments, performed with *Mimulus luteus*, *Ipomœa purpurea*, *Dianthus caryophyllus*, and *Petunia violacea*, says:—"These few cases seem to me to possess much interest. We learn from them that new and slight shades of colour may be quickly and firmly fixed, independently of any selection, if the conditions are kept as nearly uniform as possible, and no intercrossing be permitted. With Mimulus, not only a grotesque style of colouring, but a larger corolla and increased height of the whole plant were thus fixed; whereas with most plants which have been long cultivated for the flower garden, no character is more variable than that of colour, excepting perhaps that of height. From the consideration of these cases we may infer that the variability of cultivated plants in the above respects is due, firstly, to their being subjected to somewhat diversified conditions, and secondly, to their being often intercrossed, as would follow from the free access of insects." "I," says Mr. Darwin, "do not see how this inference can be avoided, as when the above plants were cultivated for several generations, under closely similar conditions, and were intercrossed in each generation, the colour of their flowers tended in some degree to change, and to become uniform. When no intercrossing with other plants of the same stock was allowed, that is, when the flowers were fertilized with their own pollen in each generation, their colour in the later generations became as uniform as that of plants growing in a state of nature, accompanied at least in one instance by much uniformity in the height of the plants. But in saying that the diversified tints of the flowers on cultivated plants, treated in the ordinary manner, are due to differences in the soil, climate, &c., to which they are exposed, I do not wish to imply that such variations are caused by these agencies in any more direct manner than that in which the most diversified illnesses may be said to be caused by exposure to cold. In both cases the constitution of the being which is acted on is of preponderant importance."

In this last example, viz. Hypericene, I think you will see this verified; the juice obtained from Hypericum is, as you know, of a reddish orange colour, turning red when treated with acid, but retaining its natural colour to a certain extent when prepared with oil. Our first spectrum, as shown in Fig. 11, represents this latter form.

FIG. 11.—HYPERICENE IN OIL.

	M.		λ.	Observations.
1	22·85	Centre	590·	Class 1. Shaded; size ·5.
2	21·55	„	554·	Same as No. 1; size ·5.
3	19·00	Commencement	498·	General absorption.

On examination it will be found to be not unlike that of red Cineraria, though the blue end in this case is absorbed. I now added a few drops of acid to the solution, stopping immediately that the change of colour took place. This addition has, as will be seen on reference to Fig. 12, had a contrary effect on the first two bands; they are, however, increased in definition, though their shapes are of Class 2 or unsymmetrical, while in the case of Fig. 11 they are of Class 1 or symmetrical, and the general absorption in Fig. 12 has advanced towards the red.

Fig. 12.—Hypericene Acid.

	M.		λ.	Observations.
1	22·92	Centre	586·0	Class 2. Very black, shaded to the right.
	21·3	End	565·5	
2	21·8	Centre	543·0	„ 2. Black, shaded to the right.
	20·2	End	526·9	
3	20·6	Commencement	512·0	General absorption.

Through the kindness of Mr. Sorby, whom I now take the opportunity of most sincerely thanking, I am enabled to say that the first of these two spectra is not the usual one given by the colouring matter of normal hypericene. He lent me a tube of pure hypericene, the spectrum of which nearly accorded with that of my acid form, though the centres of the bands were different. My first solution, Fig. 11, we are therefore inclined to think is due to the presence of a yellow substance very common in plants, which is made deeper by the addition of an alkali, and much paler by an acid, in which latter case the intensity of the absorption would be increased; the effect of this is that my solution is yellower than Mr. Sorby's, and would be made more red by acid. Perhaps it would interest you to know the coloured oil is not unlike that of the solution in water, and like this has no fluorescence.

This example now closes my remarks. I think I have brought sufficient evidence, if not of proof, to substantiate what I have said, at least enough to open up a field for an immense amount of research. The conclusion which I draw from these few specimens is, that any plant, colouring matter, or substance may be so acid that the limit of the band of total absorption may be extended beyond one's vision into the violet, or that the contrary effect may be produced on the red by an alkali in excess. That both these states may be present, and that they both may affect the spectrum in their own particular way at the same time, is evident.

II.—*Microscopic Aspects of Krupp's Silicate Cotton.*

By H. J. Slack, F.G.S., Sec. R.M.S.

(*Read before the* Royal Microscopical Society, *April* 4, 1877.)

Plates CLXXX. and CLXXXI.

Silicate cotton is the name under which blast-furnace slag reduced to a fibrous condition is now sold as a non-conducting substance for covering steam boilers, pipes, ice-houses, safes, &c. It is manufactured at the works of Herr Krupp, at Sayn, in Germany, by forcing a blast of steam, water, or air through molten slag, in the viscous state in which it runs from the furnace.

Having obtained a specimen through the kindness of Messrs. Jones, Dade, and Co., the English agents, it was found when lightly compressed to be much like cotton wool, but of finer fibre. Amongst the fibres are to be seen a number of bulbs of various forms and sizes, seldom, however, exceeding the magnitude of an ordinary pin's head, and usually less. The fibres vary in thickness from that of common spun glass to an extreme tenuity represented by fractions of a thousandth of an inch. They are easily blown about as a fine dust, and from their material, and forms, as shown in some of the sketches, Figs. 1 to 4, must be very mischievous if introduced into the lungs. It is said that special precautions have to be taken to prevent workmen engaged in the manufacture from being seriously, or fatally, injured.

The bulbs present some interesting appearances. They vary in shape and size as Figs. 5 to 17 show, and also in internal structure, though they may be generally described as solid bodies containing more or less numerous vesicles and hollows.

Considering the sudden and violent explosive action by which they are formed, little regularity might be expected in their markings, but a considerable number exhibit a very beautiful and symmetrical ornamentation. A spherule, for example, one-thirtieth of an inch in diameter is thickly covered with compound vesicles (see Fig. 18), consisting of a central clear glass film surrounded by numerous minute bubbles, the whole when lit up under the microscope having an elegant jewelled appearance.

When broken, the bulbs exhibit a conchoidal fracture diversified with small cavities and vesicles. In some cases the symmetrical arrangement last mentioned is found in the vesicles occupying the centre of a bulb. In some spherules obtained from a Yorkshire furnace by Mr. Sorby, numerous groups of crystals could be seen composed of minute prisms arranged in rectangular patterns.

To test the mode in which such regular patterns as in Fig. 18 could be formed by explosive action upon a viscous substance, an

W. West & Co. lith.

Silicate Cotton bulbs.

ounce or two of common rosin was melted in an iron ladle, and when it began to boil suddenly thrown into cold water. An irregular brittle mass was obtained, exhibiting here and there small white patches. These when examined with ½-inch power showed some compound vesicles like Fig. 18, and others as it were in process of formation. It seemed as if the first action of the explosive steam was to produce an immense number of minute vesicles, and that those in the centre had a greater tendency to coalesce than those at the margin. Some centres were composed of a single clear vesicle, others of two, three, and so on.

The general character of the silica cotton threads is much like the volcanic product known as "Pele's hair"; the bulbs resemble volcanic bombs.

In some specimens the bulbs are like common white glass; in others they glow with the iridescent tints of Venetian work, and constitute objects of considerable beauty when illuminated with a side silver reflector.

Iron slags producing this material are compounds of silica, alumina, &c.

The following analysis from Percy's 'Metallurgy' may be taken as an illustration of their composition. The specimen was from South Staffordshire, and crystallized in well-defined translucent square prisms*:

Silica	38·05
Alumina	14·11
Lime	35·70
Magnesia	7·61
Protoxide of manganese	0·40
Protoxide of iron	1·27
Potash	1·85
Sulphide of calcium	0·82
	99·81

The spun glass condition of slag is mentioned by Percy, who says,† "owing to some accidental condition the melted slag has actually been spun as it were by the blast, just as glass is spun by a wheel. I have received beautiful specimens of this kind from my friend Mr. Levick of the Blaina and Cwm Celyn Iron Works, and also from Prussia."

The fine threads of silicate cotton fuse readily into beads in the flame of a spirit lamp, but they are unchanged by a full red heat.

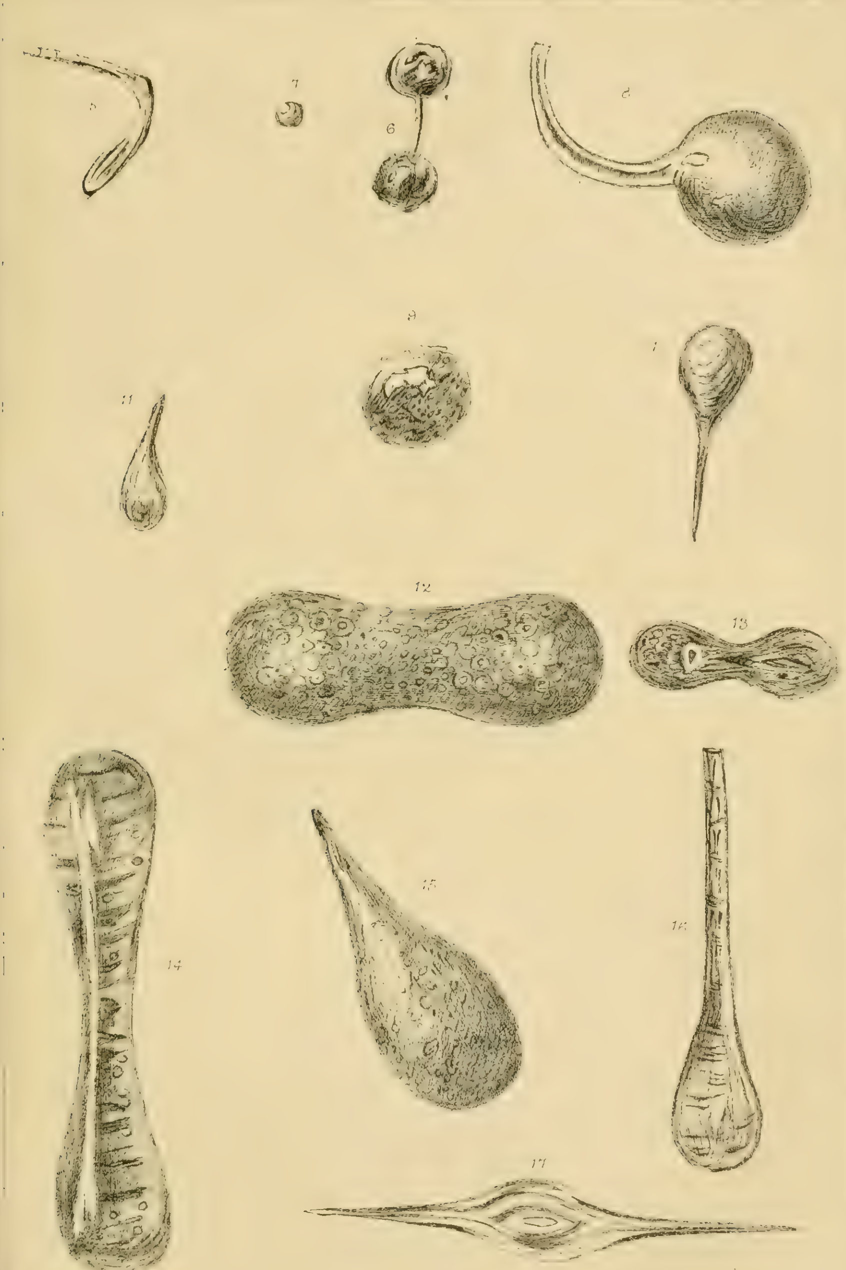
The substance is not a pleasant one to handle, and no doubt numbers of sharp, and often curved and barbed particles entering the skin would produce great irritation. On this account it is supplied

* Percy's 'Metallurgy,' vol. i. p. 23.

† Ibid. p. 27.

in the form of mattresses $2\frac{1}{2}$ inches thick, made up ready for use. Those who must handle it ought certainly to be provided with thick gloves, and great care should be taken not to inhale its fine dust.

The rapid cooling of this silicate cotton in its process of formation might be expected to give it polarizing properties, but it only possesses them in a feeble degree.



Silicate Cotton bulbs.

III.—*On the Lower Silurian Lavas of Eycott Hill, Cumberland*

By J. Clifton Ward, Assoc. R.S.M., F.G.S., of Her Majesty's Geological Survey.

(*Read before the* Royal Microscopical Society, *April* 4, 1877.)

Plate CLXXXVII.

Contents.

Introduction.

The series of lavas which I propose to describe belong to the northern extension of the volcanic series of Borrowdale, Cumberland. This series has been treated of in my memoir on the Keswick district, and touched upon in various papers communicated to the Geological Society. My object in the present paper is to point out the value of microscopic research to the field-geologist both from a practical and a theoretic point of view, and at the same time to illustrate somewhat in detail the microscopic structure of a fine succession of ancient Silurian lava-flows.

Eycott Hill lies in the north-eastern part of the Lake district, just outside the range of the mountains, and a mile and a half north of Troutbeck station on the line of railway from Penrith to Keswick. The hill is often locally known by the name of Berrier Nittles, and its highest point, through which the section (Plate CLXXXII.) runs, is 1131 feet above the sea.

1. *Examination in the Field.*

The horizontal section, on the scale of six inches to a mile, Plate CLXXXII., shows the series now to be described, dipping at a tolerably regular angle of from 35° to 40°. The interstratification of a thin band of Skiddaw slate (No. 4), near the base, would indicate that these are some of the lowest beds of the whole volcanic series, and although at this particular spot the junction between the Skiddaw slate and the volcanic rocks is a faulted one, there is abundant evidence farther north (given in Survey Reports) of the gradual passage from the one series into the other, or, in other words, of the submarine character of the *earlier* volcanic deposits, though at a later period the volcanoes became wholly or almost wholly sub-aërial. Whether the *entire* thickness of more than 2500 feet, shown in the section, represents submarine volcanic deposits is doubtful; from analogy with other parts of the district this is probably *not* the case.

With the exception of four or five thin bands of bedded ash, the whole thickness here given is made up of a succession of lava-flows. The thickness of the highest bed of ash is uncertain, since the ground is obscured by superficial deposits and the unconformably overlapping carboniferous limestone soon hides any further succession eastwards.

It is not always easy to determine the thickness of the separate lava-flows, though in many cases they differ somewhat in character from each other, and are frequently highly vesicular in their upper and lower portions. In some cases the vesicles have been most markedly drawn out in the direction of flow. On the whole, the varying character of the beds has given rise, by weathering, to a general step-like form of the hill side, reminding one of the origin of the word trap (*trappa*, Swedish, a stair).

The ash varies in character from a very fine close fragmentary rock to one made up of large angular fragments, and therefore more properly called a breccia. The colour is often a fine purple, though sometimes the finer ash has the same grey-blue colour as the lava. The latter is also sometimes of a rich purple, but is more generally some shade of green or dark blue. The various lava-flows are of all degrees of texture, from a very compact flinty rock to a finely crystalline and porphyritic one, in which the crystals of plagioclase are sometimes an inch in length. The band of Skiddaw slate interstratified among these lavas, and lying immediately beneath a finely porphyritic flow, is not more than six or eight feet thick, and is considerably hardened.

2. *Microscopic Examination.*

Perhaps the most satisfactory method of treating this part of my subject will be to take the various beds in succession, as given in the section, and describe the microscopic structure of each, where necessary.

(1) *Purple Ash.*—This rock calls for no especial microscopic notice, being clearly fragmentary, and sometimes coarsely so. Such ashes when viewed under the microscope, in a thin slice, frequently show broken crystals and fragments of lava or previously formed ash-rocks imbedded in a fine dusty base, which last, under polarized light, with crossed prisms, usually appears dark with scattered points of light.

(2) *Lava.*—Lithologically this rock presents a compact green base with yellowish or greenish tinge and small dark spots. It probably represents more than one flow, as it is about 300 feet thick, and has vesicular portions.

Microscopically, the base consists of a mesh-work of minute felspar needles mingled with chlorite and magnetite, and a good

deal of quartz in cavities. There seems to be scarce any unaltered augite, but, to judge from analogy, much of the chlorite must represent that mineral. Some of the green mineral has a transversely fibrous structure when seen with crossed prisms.

(3) *Skiddaw Slate Band.*

(4) *Lava* (porphyritic).—This highly interesting and beautiful bed is about 100 feet in thickness, and in lithological structure shows a compact greenish-blue base containing dark-green spots of a soft mineral, and large porphyritically imbedded felspar crystals, many of them an inch long.

Its microscopic character I have already described in the 'Keswick Memoir' (p. 20), and in my paper on "The Microscopic Structure of some Ancient and Modern Volcanic Rocks." * In both cases coloured drawings are given. That in the 'Survey Memoir,' fig. 10, plate ii., shows a fine augite twin imbedded in the base of acicular felspar prisms, the spaces between which are filled up with a dirty green and brown pseudomorphic mineral (chlorite and chlorophæite) and numerous crystals of magnetite. The figure in the Quarterly Journal (fig. 6, pl. xvii.) shows a part of the same more highly magnified, and that in the Plate illustrating this paper (Fig. 1) shows the character of the crystalline base, one of the green pseudomorphs, and a portion of one of the large plagioclase crystals. These last are much cracked, and contain glass cavities, portions of the base, and grains of magnetite; they present very finely the banded structure peculiar to this group of felspars when viewed with polarized light.

Augite, in crystals and grains, occurs pretty plentifully; much is in the form of pseudomorphs however (the soft dark spots before mentioned). The large twin spoken of above as figured elsewhere, contains an interesting example of a glass cavity with a bubble and two magnetite grains, with the following dimensions:

Glass cavity $\frac{9}{10000}$ of an inch in diameter.
Bubble $\frac{1}{5000}$ of an inch in diameter.
Magnetite grains the $\frac{1}{4000}$ and $\frac{1}{10000}$ of an inch.

Some of the green pseudomorphs seem to be after olivine, presenting the form and much-fissured appearance of that mineral. I have detected grains of olivine in an unaltered condition in some of these lavas, and therefore I think there can be no doubt that both it and augite were common constituents at one time, though both have been so much replaced by pseudomorphic minerals through subsequent alteration. The top of this lava is beautifully vesicular in parts, the vesicles being drawn out along the line of flow, and filled with chlorite, chalcedony, and calcite.

* 'Quart. Journ. Geol. Soc.' vol. xxxi. p. 406.

(5) *Ash* (100 to 120 feet thick).—This bed serves as a good instance of the value of microscopic examination. It is of so fine-grained a texture that I had originally taken it to be one of the more compact lava-flows, and had no suspicion of its ashy character until examining it under the microscope together with the other rocks in the same series. Unlike most of the fine ash-beds it is free from bedding, and evidently consists of closely compacted fine volcanic dust. Microscopic examination shows that the fragments are pretty uniform in size, and that many consist of lava.

Next above this ash comes a great thickness of lava-flows, between 700 and 800 feet. They are numbered on the section 6 to 13. A little farther north than our line of section a band of ash and breccia occurs among these flows, but dies out southwards.

(6) *Lava.*—Lithological: a very compact and dark base, with small felspar crystals.

Microscopically the base is minutely crystalline, with small felspar needles, very small magnetite grains, and disseminated chloritic matter. Larger crystals of plagioclase felspar very much altered. Very little unaltered augite. Some pseudomorphs, apparently after olivine. Small vesicles filled with calcspar and chlorite.

(7) *Lava.*—Lithological: compact greenish-grey base, with small felspar crystals and dark spots; breaking with conchoidal fracture.

The microscopic structure of this bed is shown in Fig. 2, Plate CLXXXII. The base consists of the usual mesh-work of minute felspar prisms with chlorite and magnetite, and in it are larger imbedded crystals of felspar, all highly altered. There are many chloritic pseudomorphs, but no unaltered augite.

(8) *Lava.*—Lithological: fine-grained base, with a reddish tinge, and containing small crystals and spots.

Microscopical: a crystalline mixture of small felspar prisms and small grains and crystals of altered augite (?), with sparsely scattered magnetite. Some larger, but highly altered, felspar crystals, and many small vesicles filled with chlorite and calcite and having a crystalline edging.

(9) *Lava.*—A compact form.

(10) *Lava.*—Lithological: a compact greenish base, with small felspar crystals.

Microscopical: fine crystalline base of felspar needles, magnetite, and chloritic (altered augitic) matter, with porphyritically imbedded crystals of plagioclase felspar, and perhaps some orthoclase pseudomorphs, after augite and olivine.

(11) *Lava.*—On the whole, similar to the preceding, but very vesicular.

(12) *Lava.*—Lithological: purplish crystalline base, with many small porphyritically imbedded crystals.

Microscopical: plagioclase crystals of various sizes imbedded in minutely crystalline base. Magnetite and chlorite, and many brownish-red specks of iron peroxide. Many of the larger crystals of felspar, besides having numerous reddish specks and lines scattered throughout them, are permeated by slender veins filled with chlorite. Portions of the base are also sometimes enclosed (or partially so) within the large crystals. No unaltered augite is discernible, but in other respects the general crystalline appearance is quite that of the basaltic class of rocks.

For a chemical analysis of this rock, see p. 246, No. 3.

(13) *Lava.*—Lithological: compact dark-blue base.

Microscopical: consists wholly of a minutely crystalline mixture of felspar needles, augite grains (a good deal altered), and magnetite, together with chlorite.

For a chemical analysis of this rock, see p. 246, No. 4.

A thin band of ash and breccia parts this thick series of lavas just described from the following.

(14) *Lava.*—A vesicular form; small vesicles in a compact greenish base.

(15) *Lava.*—Lithological: grey-blue and highly crystalline base, slightly effervescing with acid.

Microscopical: highly crystalline; plagioclase crystals from the size of the ordinary needles up to those of $\frac{1}{4}$ inch in length, showing the banded structure remarkably well. The larger crystals frequently enclose portions of the base. Magnetite, chlorite, and calcareous matter disseminated.

For a chemical analysis of this rock, see p. 246, No. 5.

(16) *Lava.*—Much the same as the last.

(17) *Lava.*—Lithological: compact grey base, with small obscurely-defined crystals and wavy reticulated lines.

Microscopically this is perhaps one of the most interesting rocks of the whole series. The base is minutely crystalline, innumerable small felspar needles all setting parallel to one another, and having a well-marked flow around larger and porphyritically imbedded crystals, much altered. Among the needles is much chloritic matter, and magnetite in fine grains. The crystalline flow is shown in plain light in Fig. 3, and under polarized light in Fig. 4. There are also certain darker bands, roughly parallel to one another, along which the chloritic matter seems to have been converted into a dark-brown or reddish product; these bands sometimes slightly cross the direction of flow.

In the example shown in Fig. 3, the porphyritically imbedded plagioclase crystals often contain parts of the base enclosed within them, and portions of their outline are very indistinct, with

margins frequently indented by the base running far into the crystals. The quantity of magnetite grains in this sliced specimen is unusually large, and imparts a very dark character to the base.

General Remarks on Microscopic Structure.

The examination of this series of lavas, and the lavas of the district in general, proves conclusively that the minutely crystalline base of small felspar needles is the prevalent form, though frequently much obscured by subsequent alteration. These needles are undoubtedly in many cases triclinic felspar, but in some they may be orthoclase twins of the Carlsbad type. The larger crystals are *generally* plagioclase, though orthoclase seems to occur sometimes. They are replaced both by chlorite and serpentine, but owing to the great number of pseudomorphs of green minerals after both augite and felspar, it is by no means always easy—unless distinctly aided by the crystalline form—to distinguish between the various original constituents. Some of the chloritic pseudomorphs have curious little yellowish granules disposed in irregular lines along them, as seen in Fig. 2. In yet other cases the replacement has been such that in polarized light the whole of the crystal shows a mosaic of different colours, as seen in one case in Fig. 4.

The many examples in which the porphyritically imbedded crystals either contain portions of the base shut up within them, or show it running far into their sides, like inlets and bays, clearly indicate that such crystals were formed previously to the consolidation of the base. The frequent enclosure of grains of magnetite within the glass cavities of the augite also points to the same fact, and to the very early crystallization of the magnetite. Indeed, the order of formation would seem to be, first the magnetite, next the larger crystals of augite and felspar, and lastly the base, so largely composed of minute needles of felspar, which frequently assume a well-marked flow around the larger crystalline masses.

With regard to the augite crystals, it is striking how many slices may be examined, and yet none but pseudomorphs after the mineral be met with, while in other cases—though rather exceptional—most of the larger crystals appear almost unaltered, and frequently exhibit well-marked twins. If this alteration be so prevalent among the larger crystals, there is but little wonder that the finer augitic matter which probably once existed throughout the base, in many or most cases should have been all completely changed, its place being taken by chloritic minerals. In Fig. 4 examples may be seen of partially altered augite crystals, under polarized light.

The great quantity of pseudomorphic chloritic matter which prevails among these old lavas entitles many of them to be classed

as diabases, and it becomes a question whether the term diabase may not thus be best employed to denote a rock belonging to the doleritic or basaltic class, in which the doleritic characters are much obscured by the presence of chlorite, or its more unstable ally delessite or chlorophæite, changing to a brownish colour on exposure. Zirkel remarks, under the head of diabase,* that the diffused greenish mineral seems to be chlorite, and probably a decomposition product of augite.

With regard to the accidental minerals, as they may be called, of these ancient lavas, it should be remarked that excessive alteration carried on through such æons of time could scarcely leave them untouched, when the prevailing constituents have undergone so much change; nevertheless both olivine and apatite may be occasionally observed, and there are few characters common to modern basalt which may not be recognized either in full or in part among some of these ancient Lower Silurian lava-flows. It now remains to be seen how far chemical analysis supports the idea of the basaltic character of *some* of these rocks.

3. *Chemical Examination.*

Having previously had several analyses made of the lavas occurring in the Keswick district, and found their composition to agree with those of a generally intermediate group between the basic and acidic series, I became anxious to test some of these more northern lavas in the same way, and especially some of those which both lithologically and microscopically appeared more truly basaltic in character. I therefore selected three samples from the series described in this paper, of varying texture and appearance, and Mr. John Hughes, F.C.S., has made me the careful analyses which will be found in the table on next page under the third, fourth, and fifth columns. No. 3 analysis is that of the lava described as (12) in our series, and is microporphyritic in character. No. 4 is a very compact variety, and described as (13) in our section, and No. 5 answers to (15), and is more like a modern basalt both lithologically, and in some respects microscopically, than any others.

A comparison of these analyses with a mean analysis of rocks of the doleritic class shows clearly a general correspondence, so that chemically there can be no reason against considering some at any rate of these old lavas as representing ancient basalts.

On comparing these three analyses with two of lava from the Keswick neighbourhood, it is seen that the latter are markedly less basic. In my previous papers I have stated my belief that many of the old Cumberland lavas represent the intermediate group answer-

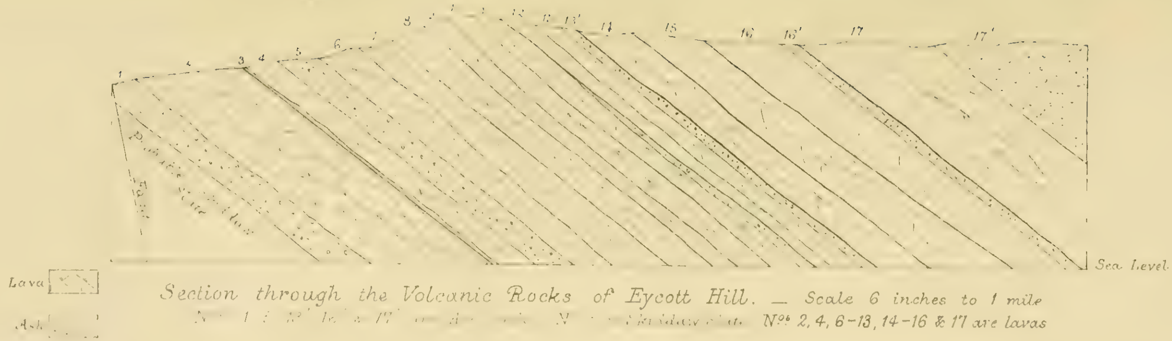
* 'Mikroskopiche Beschaffenheit,' p. 407.

ing to the modern "greystones" of Scrope or trachy-dolerites, and now I think there is equal reason to believe that at that very remote geological period, the Lower Silurian, there were erupted some lavas also of a basaltic type, and therefore that the idea formerly held of the specific distinctness of the ancient from the modern volcanic rocks is one that cannot be sustained. Mr. Allport has already shown the specific identity of Carboniferous dolerites and basalts with those of modern date, and I think that the microscopic, chemical, and field evidence which I have been able to collect among the volcanic rocks of the Lake district almost as clearly proves the existence of doleritic and trachy-doleritic lavas among the *Lower Silurians.*

Analyses of Cumberland Lavas.

	(1) Brown Knotts (Keswick District).	(2) Iron Crag (Keswick District).	(3) Eycott Hill.	(4) Eycott Hill.	(5) Eycott Hill.	*Dolerite.* Mean Analysis.
Silica	60·718	59·511	53·300	52·600	51·100	51·00
Alumina	14·894	17·460	20·990	17·315	22·051	16·06
Potash	2·354	3·705	·926	1·486	1·022	·84
Soda	2·843	3·093	2·456	2·622	2·216	2·66
Lime	6·048	5·376	8·512	7·728	11·424	9·53
Magnesia	1·909	1·801	3·964	3·252	2·346	5·18
Ferrous oxide	6·426	4·926	6·343	12·043	5·885	14·75 (Ferrous and Ferric oxide together)
Ferric oxide	1·405	1·271	1·660	1·722	1·210	
Bisulphide of iron ..	·395	·604				
Phosphoric acid ..	·281	·115	·102	·153	·179	
Sulphuric acid	·103	·086	trace	trace	trace	
Carbonic acid	1·660	1·569	·320	·140	1·820	
Loss on ignition ..	·964	·483	1·120	1·160	·710	1·42
	100·000	100·000	100·000	100·000	100·000	

Nos. 1 and 2 have been already published in the memoir on the Keswick district (sheet 101 S. E). Nos. 3, 4, and 5 are new, and unpublished in any paper or memoir.



Section through the Volcanic Rocks of Eycott Hill. — Scale 6 inches to 1 mile
[illegible] *Nos 2, 4, 6-13, 14-16 & 17 are lavas*

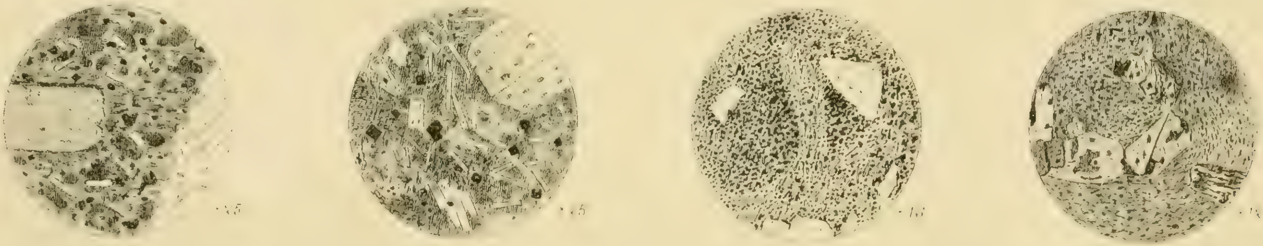


Fig 1 Fig 2 Fig 3 Fig 4

Lower Silurian Lavas of Eycott Hill, Cumberland. Drawn [illegible]
Fig. 1. Lava No 4. — Fig. 2. Lava No 7. — Fig. 3. Lava No 17. — Fig. 4. Lava No 17, in polarized light.

IV.—*The Modifications which the Egg of the [Hooded-eyed] Medusa undergoes before Fecundation.* By M. A. Giard.

We may take as a type the egg of *Rhizostoma Cuvieri.* This medusa is found in great abundance, during autumn, along the shore of Wimereux, along with *Chrysaora hyoscella* and some other Acalephs.

The smallest eggs in the ovary are formed of a transparent vitellus, enclosing a germinal vesicle and a nucleolus. One does not recognize any enveloping membrane at this stage. In proportion as the ovum increases in size, its transparency diminishes. The vitellus is charged with deutoplasm, and the germinal vesicle becomes more indistinct; at the same time one may distinguish on the periphery a very delicate vitelline membrane closely applied against the vitellus. At a further stage the egg presents on its surface a series of spherules equally spread over the whole. These are filled with a perfectly transparent substance, and are separated from the external membrane by a thin layer of granular protoplasm, identical with that which occupies the centre and covers over the germinal vesicle. An optical section of the egg may then be compared roughly with that of a young vegetable stem at the moment the first circle of vascular bundles appears, which then divides the parenchyma into three parts: one central, one peripheral, and a third radial, uniting the two. The hyaline spherules rapidly increase till they touch each other, and at the same time they attack the vitelline membrane. With a slight magnification it seems as if the vitellus was surrounded by a layer of cells which projected from its surface at right angles. More highly magnified one sees that the central granular protoplasmic mass is connected with the vitelline membrane by an immense series of little columns widened at both their extremities like the stalactitic columns we sometimes find in a cavern, uniting the two masses of stalagmite, that of the ceiling and that of the floor. These columns are constituted of a protoplasm less granular than that of the interior of the ovum. Finally, at the moment when the egg arrives at maturity, the columns break and leave only very slight thicknesses of the vitelline membrane at their former points of attachment. Then we have a central granular mass in which the germinal vesicle is not directly observable, and around this mass a transparent zone, which separates it from the vitelline membrane.

Professor Harting has seen in the eggs of *Cyanea Lamarckii* and *C. capillata* the stage in which the columns appear,* but not

* Harting, "Notices Zoologiques" ('Niederlandisches Archiv,' Band II. Heft III.).

having completely followed the preliminary phases he has given a false interpretation of the appearances observed. He considered that the ova of *Cyanea* were provided with a vitelline membrane of a considerable thickness, and pierced by a very large number of pores leading from without inwards, such, said he, as we find in the ovum of certain mammals—perhaps in all—and also in the ovum of many Teleostean fishes, where these pores have a much more considerable dimension. It is evident that these pretended pores are nothing else than columns of a clearer protoplasm to which we have already referred. Thus equally fall to the ground Harting's supposition regarding the physiological function of these pores, that they may serve as channels for the respiration of the ovum, and also perhaps for the passage of the spermatozoa inwards.

The preceding observations were conducted at Wimereux during September 1875. They were part of a series of researches not yet completed on the development of Medusæ, and I decided to publish them now because they seem to me to acquire a generality and an importance much greater than I at first supposed, thanks to the magnificent investigations of Weismann upon the ovum of the *Daphnoidæ* (Clodocera).*

Weismann has observed a process very like that which we have described, in the formation of what he calls the shell (*schale*) of the winter egg, in the genera *Polyphemus Sida* and *Daphnella.* It is remarkable that in this case, as in that of the Medusæ, the egg underwent a tolerably long incubation in a special medium furnished by the maternal organism.

The excretion of hyaline vesicles, which takes place from the entire surface of the vitellus in the ovum of Rhizostoma, may in other animals be limited to a portion of the surface. The phenomenon then will have the appearance of a sort of excreted globules. One may—in the presence of this process—ask if the phenomena frequently pointed out, of rejection of a certain part of the vitellus at the moment of the maturation of the egg, should be regarded as equivalents in all animals in which they have been observed. Bütschli has in the clearest manner shown that the corpuscles *de direction* of the egg of *Lymnæus, Succinea, Nephelis vulgaris,* and of *Cucullanus elegans,* arise by the process of cellular division. I may add that it is the same in *Sulmacina Dysteri* and in *Spirorbis.* In these various animals the excreted corpuscles have the value of *rudimentary cells,* having an atavic signification, and cannot be suitably styled refuse corpuscles (*corpuscles de rebut*). This term may, on the other hand, be applied to non-cellular

* Weismann, "Zur Naturgesch. der Daphnoiden" ('Zeitschrift für Wiss. Zoologie,' XXVIII. Band, 1 and 2 Heft).

materials, which, rejected by the vitellus, serve in the formation of accessory organs of the egg, for example of the shell (*la coque*) or the vitelline membrane. Such are the hyaline vesicles of the ovum of *Rhizostoma Cuvieri*.

Errata in the President's Address.—At page 129, in the bottom line, for *orthoclase* read *oligoclase*. At page 130, in the second line from the top, for *abite* read *albite*, and for *oligoclase* read *orthoclase*. At page 134, in second line from bottom, omit the words *of gypsum*.

PROGRESS OF MICROSCOPICAL SCIENCE.

Recent Researches on Kölliker's Dicyema.—Professor Van Beneden has made some very important researches recently on the peculiar worms that bear the above name, and which appear to be parasitic on the renal (?) organs of various Cephalopods. These researches have been fully reported by (we suppose) the younger Packard in the 'American Naturalist.' He says that Van Beneden claims of these species that they have no general body-cavity. The body is formed (1) of a large axial cylindrical or fusiform cell, which extends from the anterior extremity of the body, enlarged into a head, to the caudal extremity; (2) of a single row of flat cells forming around the axial cell a sort of simple pavement epithelium. All these cells are placed in juxtaposition like the constituent elements of a vegetable tissue. There is no trace of a homogeneous layer, of connective tissue, of muscular fibre, of nervous elements, nor of intercellular substance. There is only between the cells a homogeneous substance, as between epithelial cells. The axial cell is regarded as homologous with the endoderm of the higher animals. He designates as the ectodermic layer the cells surrounding the large, single axial cell. There exists no trace of a middle layer of cells. We discover no differentiated apparatus; all the animal and vegetative functions are accomplished by the activity of the ectodermic cells and of the axial cell. On account of these characteristics Van Beneden regards these organisms as forming the type of a new branch of the animal kingdom which he distinguishes as Mesozoa. Each species of Dicyema comprises two sorts of individuals differing externally, one (the *Nematogene*) producing vermiform embryos, the other (*Rhombogene*) infusoriform young. The Nematogenes produce germs which undergo total segmentation, and assume a *gastrula* condition. After the closure of the blastopore the body elongates, and the worm-like form of the adult is finally attained, as they pass through the body-walls of the parent. The germs of the Rhombogenes arise endogenously in special cells lodged in the axial cell and called "germigenes." The germ-like cells undergo segmentation, and then form small spheres which become infusoriform embryos. The worm-like young is destined to be developed and live in the Cephalopod where it has been born, while the infusorian-like young probably performs the office of disseminating the species; it transmits the parasite of one Cephalopod to another. This work is also an important contribution to histology, particularly to the subject of cell-division. Says Van Beneden, "the recent researches of Auerbach, of Bütschli, of Strasburger, of Hertwich, and those that I have published, have established the fact that the division of a cellule, that is to say, the multiplication of the cellular individuality, is the resultant of a long series of complex phenomena, accomplished in a determinate order, and having their seat as much in the nucleus as in the substance of the cell." Finally, Van Beneden places in his branch of Mesozoa the hypothetical Gastræades, which

term he applies to (*gastrula*-like) organisms formed of two kinds of cellules, some ectodermic, others endodermic, in which the endoderm is formed by invagination. He calls Planulades, those hypothetical Mesozoa which are formed from a many-celled sphere constituted like a Magosphæra (Haeckel) and in which the two cellular layers are developed by delamination. He therefore divides the animal kingdom into three primary groups, that is, the Protozoa, the Mesozoa, and the Metazoa.

A curious New Sponge, Kallispongia.—Professor E. Perceval Wright describes * a beautiful little sponge found growing on the fronds of some species of red seaweeds from the coasts of Australia. The largest specimens measure not three millimeters in height. The sponge consists of three distinct and well-marked portions: firstly, a small basal disk; secondly, an elongated stem, on the summit of which expands the third portion, or capitulum. The disk is button-shaped, flat, and is formed of an irregular horny framework, twice to three times as broad as the stem. The stem varies in height, and presents the appearance, in some cases, of a series of margined rings, some twenty in number, fastened together one on the top of the other; in others the margins of the rings will be more prominent, and the bodies of the rings will be, as it were, more deeply sunk. In both these cases the horny framework is of a more or less evenly latticed character, the longitudinal lines of the lattice being very prominent. The head portion, in its natural state, probably presents a more or less spherical form, perhaps slightly flattened on the summit, with an indication of being divided into four nearly equal parts, the open space between these leading into the body-cavity of the sponge. In some of the specimens the head portion nearest to the stem seems to have been formed of a somewhat denser framework than the upper portion, so that while being pressed this upper portion has been fractured across. The framework here is of a densely reticulated kind, in appearance reminding one of the reticulated network of the intracapsular sarcode in Thalassolampe, or of the tissues met with in some Echinoderms. This sponge has been called *Kallispongia Archeri.* The wonderful mimetic resemblance which it bears to some Crinoid forms can scarcely be overlooked. Leaving the texture and composition of the skeleton mass for the moment out of view, and simply looking at its outline—the circular disk-like base, the stem—the profile of which is absolutely the same, except as to size, as that of the pentacrinoid stage of *Antedon rosaceus,* and the slightly cleft head, the resemblance is very great.

The Microscopic Anatomy of Vaccination.—Messrs. Braidwood and Vacher have published a very lengthy report on this subject in the 'British Medical Journal.' In this they state the following conclusions:—*a.* The principal local changes excited by the vaccine contagium affect the rete mucosum, and consequently the hair-follicles. *b.* They consist in corpuscular infiltration of this tissue. *c.* The corpuscles to be most distinctly seen during the earlier days

* 'Proc. R. Irish Acad.' vol. ii. ser. 2, part 7.

after inoculation, infiltrating this tissue, are oval or round nucleated cells, deeply tinged by carmine. *d.* On successive days, these corpuscles are to be seen in the crypts or hair-follicles budding or throwing off minute, round, highly refractive bodies. *e.* During the later stages, when the pock has nearly matured, these corpuscles elongate into fibres, or shrink up. *f.* In becoming fibres, they encroach on the hair-shafts and hair-follicles. In none of the preparations examined by us have we observed any bacteria, fungoid forms, or allied organisms.

Dr. Klein's Observation on Small-pox.—We regret that this has not been noticed earlier, but it is of so much importance that we cannot allow it to remain absolutely unnoticed. It is this. Dr. Klein has been convinced by Dr. Charles Creighton that his observations published in the 'Philosophical Transactions' (vol. 165, part 1) are in part incorrect. He there described certain structures in the lymphatics of the skin as the mycelium of a fungus which he termed *Oidium variolæ.* He has, since Dr. Creighton published his paper, recalled his former observations. With an honesty of purpose for which it is hard to praise him too much, Dr. Klein says:—"A comparison of the two kinds of specimens convinced me that the appearances represented in my figs. 18 and 19 are not due, as I supposed, to a mycelium in the cavities of the primary pustules, but are products of coagulation of some albuminous or kindred material by the reagent that had been employed for hardening the object in question (dilute chromic acid and spirit). The vegetable nature of the other structures —viz. those represented in figs. 9, 10, and 11 (i. e. the supposed mycelium in the lymphatics of the skin of the pock), as well as those in figs. 16 and 17 (i. e. the mycelium in the cavities of the secondary pustules)—becomes therefore very doubtful. My doubt as to these being also produced by coagulation is based partly on the similarity between the last-named features and those undoubtedly non-vegetable objects in Dr. Creighton's specimens and also in my figs. 18 and 19, and partly on the following circumstances:—(1) I have lately ascertained that blood, especially in febrile conditions, which is contained in blood-vessels of tissues that had been subjected, in a fresh condition, to the hardening fluid (e. g.c hromic acid), presents appearances very similar to branched mycelium-threads to which are attached numerous conidia; the presence of more or less unaltered blood-corpuscles proves their true character. (2) I have likewise seen that blood-plasma containing globulin or parts of blood-corpuscles, when in lymphatic vessels or kindred spaces, show sometimes in the course of coagulation similar appearances. Whether the greater number of the thread-like structures is due to fibrin or to blood-corpuscles I cannot determine as yet; but it seems to me that both is the case."

Mr. Sorby on the Red Clays of the Ocean-bottom.—The President of the Royal Society, in his late address, makes the following observations on this subject:—"Before leaving this subject, I must mention the endeavour of our Fellow, Mr. Sorby, to determine the nature of the Red Clays of the ocean-bottom, of which we have heard so much.

He informs me that, though any conclusions now to be drawn from his observations must be provisional, it is safe to consider that many specimens of the Red Clay are so entirely analogous to what the Gault must originally have been, that those specimens might almost be looked upon as being as truly modern Gault as the *Globigerina*-ooze is modern Chalk. In the Gault the grains of fine sand are chiefly quartz derived from the decomposition of schistose rocks. But the Pacific and Atlantic muds from great depths contain, besides quartz fragments, others of glassy felspar, pumice, and other volcanic products; and Mr. Sorby has not been able to detect any difference between the main mass of the Gault and other rocks which are composed of very minute granules like those derived from felspar or other minerals which, in a similar manner, easily undergo complete chemical decomposition. Independent, therefore, of the presence of different organic remains, and of the modern volcanic products, there is little or no difference between the Red-Clay deposits and some of the earlier stratified rocks."

Empusca muscæ.—On this subject a paper was lately read before the Quekett Club, and appears in the last number of the Journal, by Mr. T. Charters White. He said, among other things, that the characteristic appearance of a fly affected with this disease is best detected when the fly, in its last moments, settles on a window; it then may be recognized by a zone of white deposit surrounding the fly like a halo—the fly maintains its living attitude, and will be found attached solely by the lips of its proboscis. Its legs are not crossed under it as is the case with all dead insects, but distended, as in the live state. Examining the fly now externally, you will find the hairs covered with minute white globules. These are the spores of the fungus, and are scattered also round the fly for some distance, in a very curious manner; in some cases almost as if they had been squirted out of regular points of the body. The abdominal rings are separated by about their own breadth from each other, while they seem bursting from over-distension. The thorax and head do not seem so much affected as the abdomen. On opening the fly in a little glycerine and water, the cause of this over-distension is soon discovered by the appearance of a dense mass of mycelium threads, that emerge as soon as an opening is made in the abdomen. On the termination of Mr. White's paper, a few very sensible observations on it were made by Mr. W. W. Reeves, which we quote as follows. He suggested that Mr. White might have carried the subject further with greater advantage, for if they wished to follow up the growth of this fungus they must not be content merely to watch it as found upon dead flies, this being only half its history. Let them drop the fly into water, and then see what would take place. In a short time they would see the fungus grow out and develop in a very beautiful manner. It never fully developed upon a window pane for want of sufficient moisture, but if this were supplied much more could be seen of its history. Very little was known about it, but if anyone wanted to become better acquainted with it, by placing a fly thus attacked in a little water its further growth might be readily studied. Like many of this

class of fungi it assumed different forms under different circumstances. It might be that the fly got into a diseased state, and settled upon the moist window pane—for it was only to be observed in damp weather. In the fifth volume of the 'Quarterly Journal of Microscopical Science,' p. 154, some account of it would be found; and in vol. iii. p. 55, of the early Transactions of the Microscopical Society, it was described and figured by Mr. Cornelius Varley. Mr. Reeves added that the fungus was not confined to the house-fly—it was found also on the blow-fly and several other insects.

Early Development of Sponges.—In a recent report of a meeting of the Société Vaudoise des Sciences Naturelles, 'Nature' says that Professor Forel spoke on an interesting occurrence of an early development of sponges in the Lake of Geneva, due to the unusually mild winter of this year. The fluviatile sponge of the lake consists of a horny skeleton with very fine siliceous spiculæ, covered with a sheet of soft, perforated animal matter. Usually, in autumn, this soft matter leaves the exterior ramifications and condenses under the form of small gemmulæ, half a millimeter in diameter, in the deepest interior parts of the horny skeleton. There it remains until the spring, when it expands anew upon the ramifications, and covers them with a sheet of living animal matter. But this year M. Forel observed on February 2, besides many sponges in their hibernal state, a colony of other sponges which had already reached their full summer development, differing only by a somewhat paler colour from the usual summer appearance. The occurrence is perfectly explained by the circumstance that the temperature of water in the Lake of Geneva was this year higher by two degrees than the average temperature for many years, which is 6°·3 Cels. for December and 4°·9 for January.

The Structure of Itacolumite has been recently described to the Academy of Natural Sciences of Philadelphia,* by Professor W. P. Blake. The specimens, which were obtained in California, were unusually fine, some being over 30 inches in length, and only 2 square inches in section. The colour and the structure appear to be the same as in flexible sandstone from other localities. Thin and small scales of silver mica are abundant. It bends with little resistance up to a certain point, and without elasticity, but is rigid beyond that point. When held up by one end and shaken, the motion is transmitted in wave-like vibrations as in a cord, but the limit of movement is sensibly felt like a blow or shock. A specimen 32 inches in length may be bent 7½ inches to one side or the other of a straight line. The freedom of movement is greatest at right angles to the plane of lamination. The specimens are also capable of being sensibly extended when pulled. In a specimen 32 inches long the extension amounted to about half an inch. The freedom of movement up to a certain point and the rigidity beyond that point indicate that there is a tolerably uniform distance between the grains of sand and a certain amount of movement possible among them, and that by bending, the grains are brought into contact with each other. The theory

* December 3, 1876.

of the late Professor C. M. Wetherill that the grains of sand are shaped like dumb-bells was referred to with a doubt of its correctne s. The part which the scales of mica play can only be shown by the examination under a microscope of carefully ground sections of the stone, which might perhaps be prepared for cutting by solutions of soluble glass. On concluding his remarks, Professor Blake was followed by Professor Leidy, who stated that he had examined Itacolumite microscopically without being able to detect anything like the dumb-bell structure described by Dr. Wetherill. He supposed that the intermingling of grains, differing in translucency and colour, gave rise to the impression of a dumb-bell arrangement. Thus a pair of adherent translucent grains surrounded with smaller coloured ones would give rise to such an impression.

Circulation in a Fungus.—Mr. A. Lister recently exhibited a very interesting microscopic object at the Linnean Society. It was a bit of a lowly organized fungus known as *Oldhamia utricularis*, and there was seen to be a definite current running along spaces which had certainly the appearance of vessels. This current was of a clearish liquid, having numerous corpuscular elements in it. It was kept up for a considerable space of time. Mr. Lister promised to exhibit it at the Royal Microscopical Society, but unfortunately the approach of cold weather absolutely destroyed it.

Botanischer Jahresbericht.—We learn that the first part of the third volume of this admirable work has appeared, and we take this opportunity of recording the fact. We received the two earlier volumes some years since, and we have found them very valuable *résumés* of the work done in previous years, not only in general botany, but in physiological and microscopical work.

The Reproduction of Ulothrix zonata.—An important memoir of considerable length has been published on this subject in 'Pringsheim's Jahrbücher' (vol. x. part 4), by Dr. Arnold Dodel, and there is an abstract of it as follows in 'Silliman's Journal' for February. The genus Ulothrix belongs to the order Zoosporeæ, in which the reproduction takes place by means of the *macrozoospores* and *microzoospores*, the former having four cilia and one germinative spot (the name given to the reddish-coloured dot found on one side), the latter having only two. The former bodies have for some time been considered non-sexual, while the latter have been supposed to represent sexual organs which by their union form a body with four cilia, and distinguished from the macrozoospores by having two germinative spots instead of one. This body, which is called the zygospore, corresponds to the organ of the same name in the Desmideæ and Conjugatæ proper. Dodel confirms the views of Areschoug, Cramer, and others, that the macrozoospores do not conjugate, but, after losing their cilia and coming to rest, grow at once into a new plant. He also agrees, in the main, with Areschoug as to the conjugation of the microzoospores, and besides has been able to give a more exact account of what becomes of the zygospores. He finds that they remain for a considerable time unchanged, and finally divide into a number

of zoospores, which soon come to rest and grow into new plants, as in the case of the macrozoospores. The latter it appears are more common in winter and spring, and were produced abundantly on thawing tufts which had been frozen, while the microzoospores are more common in summer. The most curious fact observed by Dodel is that those microzoospores which, for any reason, do not succeed in conjugating, grow at once into new plants just as in the case of the macrozoospores. In other words, the sexual process is reduced to the direct union of two bodies so similar that it is impossible to distinguish one as male and the other as female, and furthermore these bodies, if not placed in conditions favourable for conjugating, can at once grow into new plants. It would be difficult to find sexuality of a lower grade than this, where each sexual organ is also capable of reproducing the plant by non-sexual growth. We would recall the case of *Eurotium herbariorum* mentioned by De Bary, where, of the several male organs (pollinodia) only one succeeds in coming in contact with the female organ, yet all, after the fertilization has taken place, continue to grow and take part in the formation of the sac which eventually encloses the spores. With very rare exceptions in the Thallogens, the male organ at once atrophies after fertilization has been accomplished.

A New Parasitic Green Alga.—'Nature,' of March 8, says that not very long since it was thought that the want of chlorophyll determined the parasitism of plants, and it is still true that the want of this green colouring substance serves to distinguish between fungi and algæ. It is also true that the former need already-formed carbon compounds, but it is still thought that chlorophyll-bearing plants not only do not require to find these compounds ready formed, but that they are absolutely unable to assimilate them. It was therefore a fact of great interest when Professor Cohn described some years since (1872) a perfectly new chlorophyllaceous alga,* which he found living as a bright emerald green parasite in the thallus of duck-weed gathered at Breslau. For this the genus Chlorochytrium was established, and *C. lemnæ* was the only species until at a late meeting of the Dublin Microscopical Club, Professor E. Perceval Wright exhibited and described a second species found growing and developing itself in the mucilaginous tubes of a species of Schizonema, collected on rocks at Howth, near Dublin, between high and low water marks. There can be no question as to the parasite on the diatom being different from that on the duck-weed, while there is but little difficulty in placing it in Cohn's genus. Smaller in size its emerald lustre is scarcely if at all less than the fresh-water species, and like it its development has not been traced farther than the production of zoospores.

The Structure of Distoma sinense.—This is very fully given in a paper by Dr. W. Macgregor, of Fiji, which appears in the 'Glasgow Medical Journal' (January 1877), and to which is appended a note by

* "Ueber parasitische Algen," in 'Beit. zur Biol. der Pflanzen,' Bd. I. Heft 2.

Dr. Spencer Cobbold, fully confirming the author's views. There is an excellent plate too, representing the natural size (half-inch), and also showing its minute anatomy, of which the following is an abstract:—1. Oral extremity. There is a deep, circular, cup-shaped cavity, having the proper opening of the mouth at its base. From the mouth proceeds a tube that dilates almost immediately to form a pharynx, directly beyond which the tube bifurcates, sending a division along each side to the caudal extremity, where they terminate in cœcal ends without any branching or subdivision. These tubes are no doubt the stomach. The contents are small, granular, usually refractive particles. 3. The water-vascular system. It commences at the extremity of the broad or caudal end, and after coming nearly in a line with the blind extremities of the stomach tubes, it dilates a little, and proceeds onwards in a slightly crooked course as far as nearly one-third the length of the animal. It then divides into two branches, which proceed one to each side until they traverse the stomach tubes, when they subdivide into two branches, one of which proceeds forwards and the other backwards, just external to the stomach. The contents are small, highly refractive particles. The organs concerned in reproduction occupy the greater part of the animal. 4. The ovary — a dark oval-shaped body lying obliquely with regard to the long axis of the parasite, and almost entirely to one side of the median line, from a little beyond which it extends to the stomach tube. It varies in size and shape according to the quantity of its contents. Attached to its end next to the oral extremity of the animal, is an irregular saculated pouch. It would appear to retain the miniature eggs until they are sufficiently developed for extrusion into the uterus. 6. Ducts of the yelk-forming glands. They proceed straight from the uterine pouch one to each side of the animal, and spread out into two beautifully formed bodies, the yelk-forming glands, situated between the stomach tube and the outer edge of the animal, on both sides, as far forwards as the neutral acetabulum and as far backwards as the ovary. Their contents are of a dark brown, but after being treated for some time with a solution of caustic soda, they become of a light red colour. 8. The uterus. A long irregularly branched tube occupying nearly the whole space between the gastric tubes from the uterine pouch behind to the neutral sucker in front. In every specimen it has a dark brown colour from the multitudes of contained eggs. It opens externally upon the surface of a small papilla. 10. The two testes. They are situated the one behind the other in the posterior third of the animal. They present a beautiful dendritic appearance that varies in its details of form in different individuals. It is very difficult to trace the course of the vasa deferentia. They seem to form a common duct, the end of which is modified to serve as an intromittant organ; but my observations on this point are not quite satisfactory. The eggs are very small; they have a brown colour, which is due not to the shell or covering of the egg, but to the yelk-granules. The operculum of the egg is colourless. It is situated at one end of the egg, and seems to be easily detached, as it is not seen on many eggs, even

before extrusion from the uterus. The secretions of the ovary, testes, and yelk-glands seem to meet in the uterine pouch, and to form by their union a fully developed egg, which passes thence into the uterus. The outer covering of the animal has a tuberculated appearance under the microscope, but has no cellular formation.

Microscopic Changes in the Brain of the Insane.—This is not a subj·ct from which we can hope for much results at present. Still it is necessary to record any results that are arrived at. Therefore a paper that originally appeared in the 'Dublin Journal of Medical Science,' and which has been abstracted in the 'Medical Record' (March 15, 1877), is of interest. The author, Dr. Atkins, after referring to the elementary histology of the cortex of the brain, embraces under three heads the morbid changes he observed in insanity, affecting—1st, the nerve-cells; 2nd, the neuroglia; 3rd, the nerve-fibres. With regard to the former, the writer first alludes to the fuscous degeneration, and apparently does not hesitate to regard it as identical in its nature with the fatty degeneration of Blandford, and the granular degeneration of Major. The stages of pathogenesis are grouped under the heads of infiltration, precipitation, and disintegration. The chemical nature of the change is regarded as pigmentary rather than fatty. To the pathology of simple atrophy Dr. Atkins adds nothing fresh, and he does not appear to appreciate the fact that the so-called "giant-cells" are found, when searched for, in all brains. Under the morbid changes of the neuroglia, the coarse fibrillar appearance seen often in epilepsy is regarded as a form of sclerosis. Disseminated and miliary sclerosis are then dealt with, and the presence of colloid and amyloid bodies referred to. With regard to the nerve-fibres, Dr. Atkins appears dubious upon the significance of appearance, which (from his description) must be regarded as the varicose condition artificially produced, and which certainly does not approach the description of Mr. Hamilton's artificially induced myelitis.

The Circulatory System in Magelona.—The anatomy of this curious annelid has been gone into very carefully by Dr. McIntosh, who says of the circulatory system that the blood is a densely corpusculated fluid, the corpuscles having a pinkish colour. There are two large dorsal vessels which arise, near the tip of the tail, from the bifurcation of the ventral trunk. They pass forward along the dorsal arch of the alimentary canal, receiving in each segment a large branch from the ventral trunk and numerous capillaries from the intestinal wall, until the posterior border of the tenth segment is reached. At this part their dilated walls are supplied with powerful muscles, which, on the relaxation of the great muscles of the ninth segment, enable them to perform the functions of contractile chambers or "hearts," and by vigorous systole send the blood forward in a swift stream along the single dorsal vessel of the anterior region. On arriving at the base of the snout the vessel ends in the efferent branch to the tentacle on each side. The current rushes along the latter (nearly at right angles to the dorsal trunk) to the tips, sending off in

each a web of circumferential capillaries throughout the greater part of its length, and terminating in the afferent vessel, which proceeds backward, collecting, as it goes, the capillary streams, and then ends by turning forward at the base of the snout as the efferent cephalic vessel. The latter has no evident capillaries, but bends round at the tip of the flattened organ to terminate in the afferent cephalic vessel. A curious change takes place in the majority of those Mageloneæ which are provided with convoluted lateral organs of the body, in autumn. The cephalic vessels are much abbreviated, and the direction of the current at the base of the snout is somewhat modified. The blood from the head and anterior region collects into a series of large vascular meshes which occur in the anterior region of the body, and in which the current is for the most part under the control of the greatly developed muscles of the body-wall. Thus it happens that the contraction of the latter, and of the special muscular apparatus which closes the communication with the posterior region at the ninth segment, drives the blood forward to unroll the proboscis. This muscular arrangement in the anterior region and the muscular walls of the vessels themselves at the posterior part of the same division of the body send the current through the relaxed barrier at the ninth segment into the muscular ventral blood-vessel of the posterior region, and onward to the tail, where the trunk ends by bifurcating into the two dorsal vessels. In each segment a lateral branch leaves the ventral trunk at the anterior dissepiment, turns round and proceeds backward to the next dissepiment, and terminates in the branch to the dorsal vessel. Further, as first observed by Dr. Fritz Müller, a sac-like dilatation takes place shortly after the commencement of the latter, and it fills at intervals, the distention being followed by a contraction which sends the blood onward by the branch to the dorsal vessel. In vigorous specimens, the currents of the blood are as swift and beautiful as in the tails of young salmon and other translucent vertebrates. When examined in the *liquor sanguinis* of the living animal a distinct nucleus can be seen in the blood-corpuscle.

Professor Leidy on Rhizopods.—Professor Leidy, whose observations on those animals we have from time to time recorded in these pages, has lately read a paper containing further results, before the Philadelphia Academy. This paper is abstracted in 'Silliman's Journal' for March. It seems that Professor Leidy stated that last July, in the sphagnum swamps of Tobyhanna, Pocono Mt., Monroe Co., Pa., he noticed an abundance of a Rhizopod which he thought he had not previously seen, and which he at first supposed to be an undescribed species, but which he now viewed as a variety of *Hyalosphenia ligata*. From this, as previously described, it differs in the test being of a pale sienna colour, and perhaps of greater thickness, but otherwise is like it. The test is compressed pyriform, with the length and breadth nearly or about equal, and the thickness one-half. The lateral borders are obtusely rounded. The mouth is transversely oval. The sarcode is colourless, and attached to the inside of the test by diverging threads. The pseudopods are usually from two to three. Measurements, ·08 mm. long and broad, and ·036 thick, with

the mouth ·02 broad and ·008. Others varied from ·06 long and ·08 broad, to ·092 long by ·064 broad.

In observing the Pocono variety of *Hyalosphenia ligata*, and the beautiful and well-marked species *Hyalosphenia papilio*, he detected an important point of structure which previously had escaped his notice. In the active condition of these, and other Difflugians, they are seen with one or more pseudopods extended from the mouth of the test, to the margin of which the sarcode is attached, as well as by diverging threads to various points of the interior of the test. The interval between the body of the sarcode and the interior of the test is occupied with water. The extent of the interval increases with the increase in number and extent of protrusion of the pseudopods, and also varies according to the degree of emptiness or repletion with food of the sarcode body. When the pseudopods are withdrawn into the mouth of the test, the mass of the sarcode expands in a corresponding ratio, and the threads of attachment to the inside of the test contract in length. The intervening water appears to be displaced through small apertures of the lateral borders and fundus of the test, which exist in numbers usually from two to half a dozen or more.

While speaking of Rhizopods, he would ask the attention of the Academy to some remarks on recent observations on the habits of several species of Amœba.

One of the species of Amœba which he had most commonly seen, he took to be the *Amœba verrucosa* of Ehrenberg, with which the *A. natans* of Perty, and the *A. terricola* of Greef, appeared to him to be synonymous. This species he had found in many places: in the crevices of the brick pavement in the yard attached to his residence, in brick ponds, in the ooze of the rocky shores of the Schuylkill River, in sphagnum swamps, in marsh mud, &c. It is remarkable for its sluggish character; and in appearance reminds one of a little pile of epithelial scales, or fragment of dandruff from the head. Appearing quadrately oval or rounded, transparent, and more or less wrinkled, or marked with delicate wavy lines; the pseudopods rise in short obtuse mammillary eminences or wave-like ridges, the summits of which are composed of transparent ectosarc, while the central portion of the body is occupied by a thin, pale, diffused, and finely granular entosarc. This contains one or more vesicles, usually one, which very slowly enlarges, and then less slowly collapses. In addition, as part of the structure, an oval granular nucleus is sometimes visible. The food contents generally appear not to be abundant, and often the creature appears to be empty of food altogether. The character of its food is the same as with other species of Amœba. It not unfrequently feeds on Difflugians. In a specimen from sphagnum water, from Vineland, N.J., last August, he observed an individual, about the $\frac{1}{10}$ of a millimeter, containing a Difflugia and a Trinema together. As observed by him, the species ranges from $\frac{1}{25}$ to $\frac{1}{6}$ of a millimeter in diameter.

On the morning of August 27, from some mud adhering to the roots of *Sparganium*, obtained the day previously in a nearly dried-up

marsh, at Bristol, Pa., he obtained a drop of material for examination with the microscope. After a few moments he observed an *Amœba verrucosa*, nearly motionless, empty of food, with a large central contractile vesicle, and measuring $\frac{1}{25}$ of a millimeter in diameter. Within a short distance of it, and moving directly towards it, was another and more active Amœba, the species of which he was not positive. It was perhaps the one described by Dujardin as *A. limax*, by which name, for the present purpose, it may be called. As first noticed, this Amœba was limaciform, $\frac{1}{8}$ of a millimeter long, with a number of conical pseudopods projecting from the front broader end, which was $\frac{1}{16}$ of a mm. wide. The creature contained a number of spherical food vacuoles with sienna-coloured contents, a large diatom filled with endochrome, besides several clear vacuoles, a posterior contractile vesicle, and the usual granular entosarc. The *A. limax* approached and came into contact with the motionless *A. verrucosa*. Moving to the right, it left a long finger-like pseudopod curved around its lower half, and then extended a similar one around the upper half until it met the first pseudopod. After a few moments the ends of the two pseudopods actually became connate (the second time he had observed this phenomenon), and the *A. verrucosa* was enclosed in the embrace of the *A. limax*. The latter assumed a perfectly circular outline, and after awhile a uniformly smooth surface; but the central contractile vesicle remained in the same condition, nor did he once observe it enlarge or collapse. The *A. limax* now moved away with its new capture, and after a short time what had been the head end contracted, became wrinkled and villous in appearance, while from what had been the tail end a number (ten) of conical pseudopods projected. The *A. verrucosa* assumed an oval form, and the contractile vesicle became indistinct, without collapsing. Moving on, the *A. limax* became more slug-like in shape, measuring about $\frac{1}{7}$ mm. long, by $\frac{1}{28}$ mm. broad. The *A. verrucosa* now appeared enclosed in a large oval clear vacuole, was constricted so as to be gourd-shaped, and had lost all traces of its contractile vesicle. Subsequently, the *A. verrucosa* was doubled upon itself; and at this period the *A. limax* discharged from one side of the tail end, the siliceous case of the diatom, which now contained only a shrivelled cord of endochrome. Later the *A. verrucosa* was broken up into five spherical granular balls, and these gradually became obscured and apparently diffused among the granular contents of the entosarc of the *A. limax*. At one moment the five granular balls derived from the *A. verrucosa* appeared to be contained in three vacuoles, and the *A. limax* had a more contracted and radiate form, and then measured $\frac{1}{12}$ mm. in diameter.

The observation, from the time of the seizure of the *A. verrucosa* to its digestion, or disappearance among the granular matter of the entosarc of the *A. limax*, occupied seven hours.

From naked Amœbæ, the test-protected Rhizopods were no doubt evolved, and it is a curious sight to observe them swallowed, home and all, to be digested out of their home, just as the contents of diatoms are digested. It was also interesting to observe the cannibal

Amœba swallowing another, and appropriating its structure to its own, just as we might do a piece of flesh, completely, without there being any excrementitious matter to be voided.

The Pollen of the Coniferæ.—The 'Journal of Botany' (February) states that in the recently published 'Atti del Congresso Internazionale Botanico tenuto in Firenze,' there is an interesting paper by M. Tchistiakoff on Coniferous pollen, illustrated by two plates. Whether the grains be deprived of or provided with an air-chamber, in both cases the extine is composed of two layers, which are formed simultaneously, by transformation of the two-layered primordial utricle, where the air-chamber is absent; while in the other condition the layers appear successively, the primordial utricle being here very thin, and the inner portion of the extine being laid down from a peripheral layer of plasma which appears after the formation of the thin outer portion. At each point where an air-chamber is destined to appear is seen an interspace between the two layers of the extine, filled with a small quantity of a gelatinous hygroscopic substance. By expansion of the elastic outer extine-layer the interspaces are converted into vesicles; these are seen to be filled with a watery fluid which soon disappears, and the air-chamber is complete. Meanwhile the several-layered intine has been formed by a secretion of cellulose. The internal changes are preluded by the dissolution of the starch, the contents of the grain becoming transformed into the fovilla; at this time the outer and inner layers of the intine appear more pronounced, and the intermediate ones more or less hygroscopic. The periphery of the fovilla then becomes organized as a new primordial utricle, composed sometimes of a dense, shining, prismatic, pavement-like plasma (of a number of crystalloids, in fact), which is very well seen in *Sequoia*, *Cryptomeria*, and *Cunninghamia;* but in other cases the prismatic structure is less pronounced, or is found only locally on the circumference of the uncrystallized plasma.

Microscopical Contents of Foreign Journals.

The Journal de l'Anatomie, publié par MM. Robin et Pouchet. No. 2, 1877. Paris: Germer Baillière.—The first paper in this number of the Journal is one of considerable length, on a subject known to most of us. It is on the *Demodex folliculorum*, and is by M. Megnin. It deals very exhaustively with the subject, going into the minute anatomy of the different forms of Demodex, of which four distinct woodcuts are given. The plate which accompanies the paper gives the entire structure, the magnification used varying from 300 to 1200 diameters. In one case a hair-follicle of a dog is represented which displays the hair, and almost within the hair-sac are to be seen more than twenty Demodices. The author traces the complete development of the animal through three of its larval stages, from the condition in which it is footless to its regular eight-footed stage. He also describes the different species of Demodex, and deals at some length with their habits. The article is specially remarkable for the attack which it

makes on Mr. Erasmus Wilson, who wrote a paper on the subject of this arachnid, which is published in the 'Philosophical Transactions of the Royal Society' for 1842. It is pointed out that Mr. Wilson has fallen into the most terrible errors in his description of the animal. —A paper by M. Poincarré is also of interest to the histologist. It is upon the "History of the Thyroid Body." The author states that he has examined more than seventy glands, and these have been in all vertebrate animals, and he states that there is a general resemblance of all to each other. But he remarks that while the presence of closed vesicular spaces is undoubtedly a characteristic feature in most thyroids, yet that man's thyroid body is to some extent an exception. He found that in human glands cysts were extremely common. Out of 106 specimens examined, no less than forty-three bore cysts within them.—Another paper, which is of some interest to the microscopic anatomist, is that upon "The Origin of the Cranial Nerves," by M. Duval. This is the conclusion of a series. The magnifying power employed is, of course, extremely low.

Archiv für Mikroskopische Anatomie, herausgegeben von La Valette St. George und W. Waldeyer. 13 Band, 4 Heft. Bonn, 1877.—This number contains some very valuable and exquisitely illustrated papers. First in order is a long disquisition on the general structure of glands, by Dr. M. Nussbaum. This paper is illustrated by a plate containing many magnified representations of sub-maxillary and other salivary glands, of the glands of the pyloric end of the stomach, of the œsophageal glands, &c., &c. The most interesting paper in the entire number is that of Herr F. E. Schultze, on *Spongicola fistularis*. This is illustrated by three plates, in which we see the difficulty that the author must have had in referring the animal either to the Spongiadæ or to the Hydrozoa. It is exceedingly like the animals of both classes, and is really a connecting link of an extraordinary kind. We shall notice the rest of the contents in our next number.

NOTES AND MEMORANDA.

Angle of Aperture, Increase or Diminution of.—On this point there appears to be a considerable divergence of opinion at the present moment. We therefore publish a portion of a letter which has been addressed by Mr. Carl Reddots to the editor of the 'American Journal of Microscopy.' He says :—"I find the following in the report of proceedings of the Dunkirk Microscopical Society, in this Journal for January 1877 :

"'Professor Smith took a position radically opposed to many of the received ideas, and in favour of lenses of the widest angle of aperture for all kinds of work, even going so far as to express his opinion that most of the work in histology and pathology done with the so-called 'working lenses' of narrow angle, would require further

attention, and with wide-angled objectives, which recent advances of the optician had put at our command.'

"This question about the comparative *utility* of lenses of wide or narrow angle is one of the greatest importance to all engaged in, or intending to engage in, any of the branches of the study of pathology, histology, or biology; to all who own lenses, or who are intending to own more. . . . Now, as is said in the report, there is a wide divergence of opinion among microscopists on this subject. While a few support Professor Smith, the great majority advocate and recommend the use *only* of small-angle lenses. . . . Dr. W. B. Carpenter has the credit of being one of the most influential advocates of the small angles. The writer of this is in possession of information that, within a few months, an objective of the highest possible air-angle was shown to Dr. Carpenter at his own house, and he asserted that he saw a certain histological subject *better than ever before.* Rev. Mr. Dallinger, of Liverpool, and his associate, Dr. Drysdale, have been for some years making the most important contribution to biology ever made. The writer has seen a letter from Mr. Dallinger that the flagella of a certain monad had been invisible to *all* objectives *save two*, both of the highest attainable angular air-aperture. Here we have one case of more and one of better. Will our American histologists contribute their facts?"

Death of Professor Panceri.—We have to announce the death of this distinguished anatomist, which occurred quite recently. He was suddenly attacked whilst in the act of addressing his class at the University of Naples, and died in a few moments. It is supposed that the cause was disease of the heart.

CORRESPONDENCE.

The Microscopical Examination of Blood Stains.

To the Editor of the 'Monthly Microscopical Journal.'

No. 1835, Chestnut Street, Philadelphia, Penn.,
March 14, 1877.

Dear Sir,—I fear you and your readers are almost as tired of the blood question as you are of the angle of aperture controversy; yet I hope you will, in simple justice, allow me to make one remark, in reply to your severe editorial comment, in your February number, upon my views.

Permit me to say, that you have been entirely misinformed respecting the claim I advance, which is *not* that we can distinguish human blood from that of the guinea-pig or dog, as photographed by Dr. Woodward, but only that in regard to stains containing corpuscles within the range of human blood-discs ($\frac{1}{3200}$ to $\frac{1}{3600}$), and

falsely alleged by a criminal to be those of some domestic animal slaughtered for food, we can aid the cause of justice, by testifying *positively* that the blood never came from an ox, pig, or sheep, the corpuscles of which, unfortunately for rogues, measure less than $\frac{1}{4000}$ of an inch in average diameter. In this respect I am so far from being "unquestionably wrong," that I will undertake to prove my position, to the satisfaction of any honest inquirer of good standing, who desires to test the question, by sending me unmarked *fair* specimens of blood-stains, under the conditions mentioned above.*

Very respectfully yours, &c.,

Jos. G. Richardson.

PROCEEDINGS OF SOCIETIES.

Royal Microscopical Society.

King's College, *April* 4, 1877.

H. C. Sorby, Esq., F.R.S., President, in the chair.

The minutes of the preceding meeting were read and confirmed.

A list of donations to the Society was read, and the thanks of the meeting were voted to the donors. The attention of the Fellows was particularly called to a donation of 150 slides of various objects, included in the list, presented by the Rev. R. H. Nisbett Browne, and a special vote of thanks to that gentleman was unanimously passed.

The President announced that arrangements had been made to hold a scientific evening meeting on the 18th inst.; also that leave had been obtained to use the lecture theatre for the first Quekett lecture by Sir John Lubbock on May 2. That being an ordinary meeting day, there would be a little formal business to transact at the commencement of the proceedings, and when this had been done, the remainder of the evening would be occupied by Sir John Lubbock. At the end of the meeting the Quekett medal would be presented to the lecturer. Tickets of admission would be issued in due course, when every Fellow would receive one personal ticket, *not transferable*, and one transferable ticket for the admission of a friend. He had also been requested to intimate that a new list of Fellows of the Society was in course of preparation, and to ask that any alterations or corrections might be at once forwarded to the Assistant-Secretary, Mr. W. W. Reeves.

Mr. Thomas Palmer read a paper "On the Variability of the

* We do not doubt the accuracy of Dr. Richardson's remarks in his new and qualified position. But so long as it is impossible to distinguish human blood from that of the dog, we think that the medical jurist cannot place much reliance on the microscope in his investigations. Still we think Dr. Richardson must be complimented upon the importance of his researches.

Chlorophyll Bands in the Spectrum." The subject was illustrated by drawings, and the paper will be found printed at p. 225.

The President, in proposing a vote of thanks to Mr. Palmer, said he was very glad to find that others beside himself had taken up the question of the spectra of the colouring matters of plants. The subject was one which he had worked at for some years, and it had proved so extensive that he felt he was only just beginning the inquiry. These colouring matters are much more complex than is generally supposed, most of them are undoubtedly mixtures of two or three kinds of matters, and even the chlorophyll—the green colouring matter alone, is composed generally of two green matters, which exist separately in certain plants, and yet these facts had been overlooked by all observers excepting Professor Stokes and himself, and certainly they had been entirely ignored by all the Continental observers. The line it would be most important to carry out would be what were the chemical differences which gave rise to these changes in the spectra? This was a line of inquiry which would necessarily take a very long time, and would involve an immense amount of work on the part of an observer. There was a great deal yet remaining to be done, and he was extremely pleased to find that the subject was being now taken up.

The thanks of the meeting were unanimously voted to Mr. Palmer for his paper.

Mr. Palmer said he had noticed a curious effect some time ago when examining a red solution of litmus; he found that when very bright light was obtained by using an angular prism as the reflector, instead of the spectrum going off quite black towards the violet end, he could see the line H_2 through the dark band.

Mr. Hawkins Johnson inquired whether the absorption bands shown by a fluid under the spectroscope indicated any more than the difference in the colours of fluids, and whether the instrument was capable of distinguishing between colourless solutions, for example, between chloride of potassium and carbonate of soda?

The President said that though there might be in some cases differences observed between solutions which appeared to have scarcely any colour, the spectroscope was not competent to distinguish the difference in the chemical qualities of two such solutions as those named. He had, however, little doubt that there were many substances which appear colourless, which would give definite spectra if our eyes enabled us to see farther into the red or the blue ends of the spectrum than they are able to do.

The President said they had a paper that evening by the Abbé Rénard, which was of much interest in a geological point of view. The Abbé was present, but although he spoke English well, he felt he would rather not read the paper himself, though he was quite willing to address them in French. That course, however, being unusual, at his request Mr. Ingpen had kindly undertaken to read a *résumé* of the paper, the whole of which would be printed in the Journal.

Mr. Ingpen then read a *résumé* of a paper by M. l'Abbé Rénard, of Louvain, "On the Mineralogical Constitution and Microscopical Characters of the Whetstones of Belgium."

A vote of thanks to the Abbé Rénard for his communication was carried by acclamation.

The President said that the subject of the mineralogical constitution of these rocks was most important, and they were of much interest to English geologists, seeing that there were none at all like them to be found in this country. The occurrence of garnets in them, however, need not surprise, because they were frequently found in the slate rocks of our own lake districts, though perhaps not quite in so great a quantity. He thought that the slates of this character must be looked upon as thoroughly metamorphic, although they were not generally considered so; and therefore he regarded it as highly desirable to work out the subject in order to make out if possible what changes had taken place in the substances composing them. He might mention that the Abbé Rénard was the author of some of the very beautiful illustrations of the microscopical structure of rocks which were exhibited at the Loan Collection at South Kensington.

A paper by Mr. H. J. Slack (who was unfortunately prevented by indisposition from being present at the meeting), "On Krupp's Silica Cotton," was taken as read, the President giving a summary of the general results, and explaining that it referred to the minute fibrous particles produced when a powerful blast was directed upon a quantity of melted glassy furnace-slag. Many of the little particles so produced were like small shots, with one or more fine thread-like tails attached to them, and when the process was carried on in the open air, the whole place became filled with these minute particles, which were, from their hardness and sharpness, extremely detrimental to the lungs of persons who inhaled them. Mr. Slack's paper had reference to the various shapes of the little spheres, and to the remarkable regularity which existed amongst them, as well as their curious markings. The President said that these spheres are of great interest in connection with the structure of meteorites, and might explain the formation of a number of round glassy particles which he had often found in those bodies. Nearly all the peculiarities of the artificial product may be referred to the tendency of a liquid to collect into spheres and of a viscuous glass to be drawn out into fibres. Mr. Slack's paper was accompanied by some illustrative drawings, and a slide, in further illustration of the subject, was exhibited in the room.

The thanks of the meeting were unanimously voted to Mr. Slack for his communication.

The President said that they had received another paper to be read that evening; it was from Mr. Clifton Ward, "On the Lower Silurian Lavas of Eycott Hill, Cumberland." The paper was rather too long to read *in extenso* at that late hour of the evening, but Mr. Stewart would read the introduction and the general conclusions. The whole paper would be printed in the Journal (at p. 239).

Mr. Charles Stewart then read so much of the paper as explained the leading results.

The President proposed a vote of thanks to Mr. Clifton Ward for his paper. The subject was one of considerable importance, because at one time it was thought that there was a great deal of difference between the composition of the ancient and modern lavas. This was

due, in part, to the fact that these old lavas had undergone a great change since their first formation; in fact they were really metamorphic in a very legitimate sense of the term. Mr. Ward's paper showed that originally they were in composition very much the same as some modern lavas. Mr. Ward had worked out the subject in a most admirable manner, and the results of his investigations would be found to be set out in his paper in a very complete and satisfactory way. He thought the Fellows might congratulate themselves in having such a subject, so ably treated, in the course of their transactions.

A vote of thanks to Mr. Ward was then unanimously carried, and the meeting was adjourned to May 2.

Donations to the Library and Cabinet since March 7, 1877:

	From
Nature. Weekly	*The Editor.*
Athenæum. Weekly	*Ditto.*
Society of Arts Journal	*Society.*
American Journal of Microscopy	*Author.*
The Directory of American Naturalists. By Saml. E. Cassino. 1877	*F. Habirshaw, Esq.*
Transactions of the Natural History Society of Northumberland and Durham. Vol. V. Part 3	*Society.*
Journals of the Linnean Society	*Ditto.*
Archivos do Museu Nacional do Rio de Janeiro	*Le Directeur-Général.*
Reports of the Juries, Exhibition 1851	*Frank Crisp, Esq.*
Micro-Chemistry of Poisons. By Theo. G. Wormley, M.D. New York, 1867	*Ditto.*
One hundred and fifty slides (various)	*Rev. R. H. Nisbett Browne, M.A.*

David Bogue, Esq., was elected a Fellow of the Society.

WALTER W. REEVES,
Assist.-Secretary.

Scientific Evening of the Royal Microscopical Society.

A scientific evening was held at King's College on Wednesday, April 18, of which a detailed account, too late for the present number, will be given in the next one. We may mention that the upper set of rooms of this Institution were thrown open, and were filled by members who exhibited a vast variety of objects—many of them living—and apparatus of novelty. Tea and coffee were served in an adjoining apartment, and altogether the meeting was a most pleasant and successful one.

THE

MONTHLY MICROSCOPICAL JOURNAL.

JUNE 1, 1877.

I.—*On the Mineralogical Composition and the Microscopical Structure of the Belgian Whetstones.*

By Rev. A. Rénard, S.J., F.R.M.S.

(*Read before the* Royal Microscopical Society, *April* 4, 1877.)

Among the rocks used as fine whetstones, there are none, I think, more justly celebrated in Europe than those found in the neighbourhood of Viel-Salm, in the province of Liege, Belgium. They are in shape parallelopipeds, composed of a stratum more or less deeply coloured yellow, and of a stratum coloured blue-violet; and are exported to every country in Europe and the Orient.

Although I intend to direct attention chiefly to their constitution as found from their study under the microscope, and to the light which this method of study throws upon the origin of those rocks and upon their physico-chemical constitution, yet I shall briefly notice some of the interesting geological considerations relative to their bearing and to their relations with the adjacent strata.

The hones of the neighbourhood of Viel-Salm are found among the rocks which Dumont called Salmien, but which seem to resemble very much the English Cambrian, and to be the equivalent of the schist of Tremadoc.

They form veins in the Cambrian slate of from one to two centimeters thick, but whose direction is so irregular, and whose composing strata are so winding and tortuous, that many geologists have mistaken them, and they have been not seldom described as real veins; whilst I have shown, supported, moreover, by Baur and Dumont, that they are regularly intercalated in the stratification, and form real strata in the slate, with which it is intimately united.

The facts upon which I base my deductions and the macroscopical descriptions, are given at length in a memoir which I devoted to this question.

Before touching upon the microscopical study, let me say a word or two on the relations between the whetstone and slate, as by that means I may be more readily understood in the description of the whetstone as it appears under the microscope.

When one sees a hone having one layer of a yellowish white

material, and another of bluish slate distinctly separated by a straight line, sometimes of perfect regularity, there is a tendency to suppose that they are two fragments of different rocks fastened together one above the other, the juxtaposition being due rather to art than to nature; but when these stones are seen in the place which they occupy in the strata, one readily observes that the vein of whetstone is intimately united to the slate, and that the workman has nothing else to do than to square the fragments. In certain exceptional cases, however, art is made to imitate nature; and the workman sometimes, by fastening together fragments of different colours, gives to the market a hone that differs not in appearance from those formed by nature.

Although this line of demarcation is usually found very distinct between the two layers and marking the direction of stratification, it also happens frequently that the whetstone passes imperceptibly into the slate, in such a way that at a certain point it is no longer possible to distinguish whether slate or whetstone is in question. It might be said there was a sort of mutual penetration of the two layers.

There is one character, common to the veins and the incasing layers, to which special attention should be given. It is this: the foliation, oblique to the stratification, is prolonged from the slate into the whetstone. Sometimes this foliation is but faintly characterized in the compact varieties, but it is always present in a latent state, and if the slate be broken, the lamina comes off, passing across the whetstone, and the fissure is prolonged with a regularity and constancy of angle which shows evidently that the two rocks have a common cleavage. I have proved that there is also present in these two rocks a second cleavage, not so easy, but, like the first, clearly distinct from the stratification. The existence of this cleavage shows, first, that the layers of whetstone existed before the uplifting of the strata; and the coexistence of the two cleavages obliges us to admit that the rocks of this group have been subjected on two different occasions to a pressure, brought to bear in two different directions, as contended in similar cases by Mr. Sorby. The easier cleavage must have been produced while the rocks were still in the plastic state, the second when they were already more solidified. I have dwelt upon the characters common to the two rocks, because they are in close relationship with the details of microscopical analysis which follow. To sum up, the whetstones are contemporary layers with the incasing slates, and have been subjected to the same mechanical actions as all of the phylladic rocks of this group.

After this exposition, belonging rather to geology, let us inquire what are the minerals that constitute the whetstone of the neighbourhood of Salm. It should be remarked that this question cannot

be answered by macroscopical examination alone, since the compactness of the rock and the fineness of its grain is such that, even with the aid of the magnifying glass, it is impossible to individualize the mineral species which make up the whetstone. It appears in general as a homogeneous substance of clear colour, and the geologists who have occupied themselves with this rock have limited themselves to giving the description of some of its physical properties and the details relative to its bearing, touching only incidentally on its composition. This, however, is not surprising when it is remembered that these skilful observers had not at their disposal microscopical analysis, which I have been able to use.

Still, on examining with attention the laminæ or the fractures, peculiarities may be seen at their surface which give a glimpse of the elements that microscopical analysis makes known. With the naked eye phylladic plates, closely aggregated, may be perceived. This phyllite has not the silvery or pearly aspect of sericite; neither has its pyrognostic characters. It is these lamellæ which make up the fundamental mass of the rock. By the reflexion of a strong light there may be seen on these phylladic membranes a glistening due to crystalline granules of infinitesimal dimensions. These shining grains would naturally be attributed to quartz, were it not that study at the microscope discovers in them optical properties and crystalline forms which put aside this supposition. The microscopical dimensions of the elements mingled with the phyllite never determine the structure which we have called by the name of *gneissic* in our study of the rocks of the French Ardennes; at least, it does not appear to the naked eye nor under the magnifying glass. Among the accidental elements visible to the naked eye should be counted iron glance, hydroxid of manganese, which often impregnates whetstone, quartz, and pyrophyllite.

Let us pass now to the study of the ultimate constitution of the whetstone, as shown by microscopical analysis. In order to come at the results given in this paper, I have cut and polished more than seventy thin sections of this rock. To have a general idea of the ultimate structure of the whetstone, we should study it first with the help of weak magnifying powers. There is then perceived a colourless micaceous substance which seems to make up in great measure the fundamental mass. These phylladic fibres, generally elongated and colourless, appear peppered with a black dotting, owing to a numberless quantity of granules which have the appearance of opaque points. There are seen also innumerable microliths, some like simple dashes, and others of larger dimensions, but much more rare, showing a light bluish tint. Finally, with the help of a polarizing apparatus, it may be seen that one part of the mass belongs to an isotropic substance.

Commonly the phyllite is completely covered by the prodigious

number of particles, more or less circular, scattered along the surface of the filaments. The elongated microliths are in line, and grouped with their greater axis parallel to the direction of the micaceous laminæ. Clearer regions are also remarked in this mass, almost without interpositions, the arrangement of which contrasts with the general disposition of the elements. These veins, having a thickness of less than a millimeter, advance irregularly across the rock. They are made up chiefly of micaceous substance, and do not seem to be fissures filled up later on, but rather to have been formed at the same time that the rock took its distinctive petrographic character. They are found to contain, though in small proportions, all the elements which we discover as constituent parts of the whetstone. A fissure, filled later on, would not be filled with all the substances identical with those which form the rock. This kind of microscopical *primary veins* does not cross the whole of the thin section. They often form lenticular regions in it, of the same structure and composition as the little veins of which we have just spoken.

None of the microscopical characters by themselves allow of a certain identification of the lamellæ with a determined phyllite. I give up, however, the opinion of Dumont, who considered, without sufficient proof, pyrophyllite to be the constituent principle of the *phyllas* of the Ardennes; and I would bring these phyllitous fibres into connection with Damourite, a mineral which the chemical analyses of Messrs. Davreux and de Koninck, jun., have shown to exist in a garnet-bearing rock of Salm, that presents, as will be seen, many analogies with the whetstone. Still it is very difficult to decide this point with certainty, since it is impossible to isolate the lamellæ for a separate analysis, and they are dotted with foreign minerals. On the other hand, the optical reactions are unsatisfactory; for, as is known, one of the problems the most difficult of solution in the microscopical analysis of rocks is the specific determination of the different micas, especially when they are found without distinguishable crystalline forms, and with extremely small filaments, as is here the case.

Let us now pass to a more minute study of the different elements contained in that rock. For this we must use a magnifying power of from 400 to 600 diameters. With such aid we may perceive the innumerable granules, scattered over the surface of the laminæ, become clearly and distinctly individualized, and the rock, at certain points, appears to be composed of globular forms whose agglomeration almost completely veils the micaceous element. The mean dimensions of these circular forms rarely exceed 0·02 mm.; and, according to an approximative calculation, some parts are so beset with them, that a millimeter cube of rock contains over 100,000. These globules, for the most part rounded, sometimes also elongated, are, in some cases, terminated by crystallographic forms. They

may be perceived to be bounded by regular lines, and one may discover their lozenge-shaped faces, which are to be referred to the rhombo = dodecahedron. The dimensions of these crystals are ordinarily so minute that they are not attacked in the polishing process, and thus they are preserved to us in the integrity of their form. They are therefore, in general, complete on all sides. It is difficult to judge of their optical properties, as they are set in a double refractive substance; but by observing those of larger size that protrude on both sides of the micaceous laminæ, or those isolated at the extremities of the thin sections where the thickness is least, they may be seen to be dark between the Nicols' crossed prisms.

Their perfect isotropism and their crystalline form place them amongst the minerals of the first crystallographic system. Seen by transmitted light they appear completely devoid of colour, bordered by zones of deep black, which diminish in intensity toward the centre of the crystal, where the colourless part sparkles with exceeding brilliancy. I have found these crystals in great numbers in all the various kinds of whetstones of the Salm formation. At one time they are gathered together at one point, at another they form lines or chaplets, and again they are isolated.

With this ensemble of characteristics one may ask to what mineral species we are to refer these globular-formed crystals. However strange the conclusion may appear, I refer them to the garnet. In support of this I may show that the interpretation making it a garnetiferous rock is in no way opposed to any of the details of the micrographic description I have given, that it explains naturally all the facts that I have mentioned as well as the physical properties of the whetstone of Salm.

The rhombo = dodecahedral forms, or globular crystals, which, however, now and then present a rhombic face, point out a mineral of the first system. The single refraction on which I before insisted now comes to support my interpretation. The high index of refraction of the garnet ($\mu = 1{\cdot}772$) shows itself by the unusual brilliancy displayed by the crystals when observed by transparency.*

The high specific gravity of the rock ($= 3{\cdot}223$) is also explained by the density of the garnet, which forms a great part of it. The specific gravity of garnet, as is known, reaches to $3 \cdot 4$ and even $4 \cdot 3$. Hitherto it has been frequently asked what the substance could be that enabled these whetstones to wear even steel, and it was the supposition up to the present time that the element

* To explain this fact, it is to be remembered that luminous rays penetrating a refracting body by a point, and forming at the point of incidence a hemispheric pencil, form in refraction a cone whose angle at summit is given by the equation sin. $r = \frac{1}{n}$. This angle diminishes in proportion as n increases.

was no other than quartz finely divided and dispersed through the stone. My researches prove, however, that they contain scarcely any quartz. Hence it is to the garnets that we are to attribute this hardness of the rock, for we know that the specific hardness of garnets is comprised between 6·5 and 7·5 of the scale of Mohs. The discovery of garnets in the slates of Recht by my friend Dr. Zirkel, Professor at the University of Leipsic, is another support of this interpretation, as the slates of Recht belong to the same formation as the rocks of Salm, of which they are the continuation in Germany.

The largest garnets of our preparations show inclusions which are found so often in this mineral when studied under the microscope; we observe also in the largest those irregular fissures which are so characteristic of garnet.

But how is the yellow colour of the whetstone explained if we admit that this rock is, as we have said, almost exclusively composed of garnet? In our endeavours to explain this colouring, we have succeeded in determining the sort of garnet to which this mineral belongs. We place it in the variety called Spessartine, and we shall soon see that another kind of proof confirms us in this classification.

In considering spessartine as the principal element of the whetstone, we see that the union of a very great number of infinitely small crystals of this mineral should produce, when regarded "*ensemble*," a yellowish-white tint; for the purest spessartine is in little transparent crystals of a pale yellow, in the island of Elba, at St. Marcel, in the diamond sands of Brazil, and in Maine in the United States. We thus easily understand, in admitting that spessartine is present here, how an agglomeration of small garnets of this variety can produce the yellow tint of the whetstone. But what indicates still more certainly the manganese garnet is chemical analysis. M. von-der-Mark has found as much as 21·71 per cent. of MnO, and M. Pufal has found 17·54 per cent. in a specimen he has had the kindness to analyze for us. This large quantity of manganese should not cause surprise, since it is known that the spessartine of Haddam, in Connecticut, analyzed by Rammelsberg, gave 33 per cent. of MnO. Let us also bear in mind that the presence of manganese manifests itself in a remarkable manner when tested by a bead of borax. Let us also remark that all the surrounding rocks are as it were impregnated with manganese; it is found in the form of veins, or combined in the remarkable metamorphic minerals (ottrelite, dewalquite, &c.) of that region.

And it is near veins of whetstone that MM. de Koninck and Davreux discovered the beautiful little garnet crystals of which they have given the description,* and whose composition approaches

* 'Bulletins de l'Académie Royale de Belgique,' 1873.

more nearly that of the typical variety of spessartine than that of any specimen of which an analysis has been published up to the present. I may add, that some specimens of whetstone have lost their colour through an impregnation of hydroxid of manganese. These became completely black, but in thin sections there immediately appeared all the essential elements of the rock, coloured, however, a faint brown by the foreign matter.

A third element of the whetstone of Salm is schorl. This mineral is far less widely spread than the two which I have just made known. The principal microscopic characters which this mineral offers in the rock are the following: the form of the sections is that of a parallelogram whose great axis may have on an average from 0·07 mm. to 0·08 mm. In width it reaches 0·01 mm. Ordinarily the sections of the mineral are terminated at one extremity by planes intersecting each other at an angle more or less open; the opposite side being terminated by an almost straight line. They are traversed by crevices which are sensibly parallel to the base, and often appear notched. Their tint is not homogeneous; it is pale green, blue, greyish, sometimes growing stronger at one extremity of the section. This mineral is birefringent, and is strongly dicroscopic. The sections are often filled with black and opaque little spots. It is known, moreover, that M. Angor has discovered this mineral in a great number of slates and schists. We find again in our thin section a most perfect resemblance between the mineral he considers to be schorl and those which we have been led to consider as the same. The forms of that mineral, we have said, show a difference of development for the two extremities: this difference is the very same as that which affects schorl; which presents us so frequently with the most classic examples of enantiomorphism. We have said that certain sections show two different tints at the two extremities; this difference of tint is a well-known fact in the case of this mineral. Indeed, we know that the transparency of the tourmaline varies in the same crystal with the direction relative to the axis of the rhombohedron. It is more sensible in a perpendicular, and feebler in a parallel section, a fact which must be referred to its dicroscopism. But besides this phenomenon it is not uncommon to find that the same crystal presents different colours at the two extremities, or at least a tint of unequal intensity. According to M. von Lasaulx, the same thing is noticeable in the microscopic tourmalines enclosed in the garnets of the granulites of Saxony. We have just said that these crystals of schorl sometimes appeared as if broken; that they had undergone certain deformations. We remark, indeed, that these small sections of schorl appear broken, and that their various fragments lie at a short distance. M. Rosenbusch observes that those which are seen by the microscope are

ordinarily curved, a fact we have remarked ourselves. As we have said, it is not rare to find the sections of schorl furrowed by fissures more or less parallel to the base. It was believed by some microscopists that this fissure represented a cleavage. Now, the best mineralogical works make no mention of a cleavage in this direction. Dana, Naumanm, and Des Cloizeaux mention cleavages only following R, ∞ P 2; besides this, these cleavages are not easy. We are therefore inclined to admit that these ruptures are the effect of mechanical action, as, for example, the stretching of the beds at the moment of foliation. The rupture in these little prisms must necessarily be made parallel to the base, where the points of more feeble resistance are found. I add that M. Zirkel and myself have been able to prove that these prisms belong to the hexagonal system. In a research that I made with him, we have found that in a thin section of a schist of the Ardennes a hexagonal section of this dicroscopic mineral was dark between the crossed Nicols' prisms. This fact wholly confirms our interpretation as to the crystalline system of these little prisms.

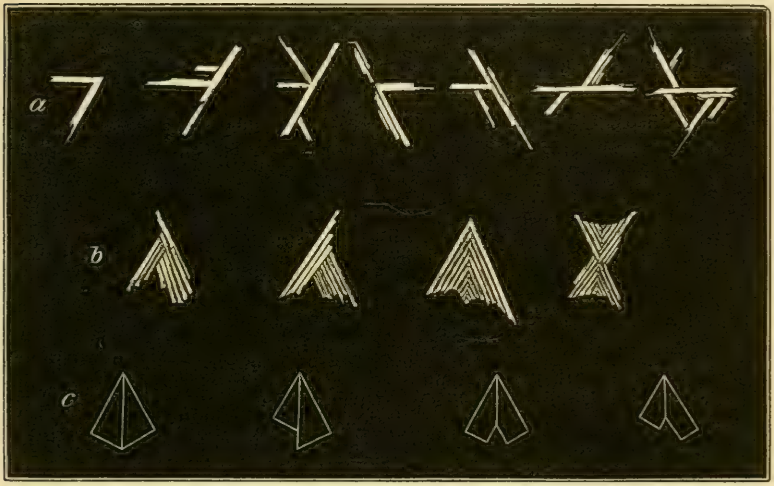
In the few pages devoted by M. Zirkel to a microscopic description of the slates of Recht, he pointed out the presence of a prismatic mineral of a greenish yellow colour. High powers of the microscope are needed to observe this mineral, the prisms not being more than 0·03 mm. in length and 0·005 mm. in thickness, so that it is difficult to determine all the faces of the crystals, which, though complete, have not very well defined edges. Irregular aggregations are often found composed, sometimes of one or two individuals, sometimes of twins in the form of a knee. As none of the characteristics of these small crystals are opposed to those of augite,* M. Zirkel believed that he could class it with that mineral. Such are, in brief, the micrographic details he gives upon these microliths.

We find them again in great abundance in the whetstone, and there under a great variety of very interesting crystalline forms, which have not as yet been pointed out by any micrographer. These prisms, which are identical with those remarked by M. Zirkel, are scattered through the whetstone sporadically, and are distinguished from the prisms of schorl by their form, by the way they are grouped, by their tint, and also by their exiguity. At different times these prisms are ranged in lines, verge towards each other, and interlace, maintaining the while almost constant angles in their superposition. In some sections it is remarked that the prisms follow the undulations of the micaceous substance. We shall add nothing to the excellent description which M. Zirkel has

* On this subject M. Zirkel remarks that our friend C. A. Lossen, of Berlin, has found in inferior Devonian, near Winterburg, some crystalline schists in which the macroscopic augite appears as an essential element.

given of the simple crystals of this kind. We find, however, in our sections, remarkable examples of grouping and of twins, of which we shall speak more in detail.

When there is a certain quantity of these microliths gathered together, one is sure to remark, for some among them, a certain manner of adhesion or of superposition, which is too regular and constant in its repetition not to be subject to some crystallographic law (Fig. *a*).



Among these little crystals those of simpler form show the geniculated twins with an angle of about 60°, and in general it is with this angle that the crossings or superpositions of the minute prisms take place. Oftentimes it is a granule of spessartine that serves as a point of attachment. The prisms do not preserve the same thickness through their entire length. In the upper part, for example, they appear a simple line, and toward the middle they suddenly bulge or swell out. Finally, in many cases they give rise, by their ramified disposition, to forms that may be considered as the skeletons of crystals that I have discovered in the whetstone of Sart, and of which I am now about to speak.

In the thin sections of this whetstone there are to be observed triangular compound crystals, yellow, less transparent, and whose dimensions reach even to 0·05 mm. (Fig. *b*). These groups may be reduced to a single fundamental type, namely, a heart-shaped twin having an angle of 60° at the summit. These crystals are formed of minute prisms that adhere to one another very perfectly, of which I have spoken above. These sections are covered with parallel striæ on both sides of the triangles, producing very dis-

tinctly those striæ which crystallographers generally call *oscillatory*.

It is not the microliths of Sart, however, that show the most remarkable crystalline forms. Some specimens of the whetstone of Ottrez exhibit, with a microscope of 600 or 700 diameters magnifying power, a multitude of minute triangular crystals of the utmost delicacy and perfection (Fig. *c*). It has been shown that these little geometric solids are to be classed, on account of their angular measure and their form, with the geometrically disposed microliths of Sart and with the geniculated twins. But, on the other hand, inasmuch as the fundamental character seems to point them out as belonging to those regular aggregations, even in so much do they differ from them by their perfect transparency. They are not formed by the gathering together of a number of minute prisms, as is the case in the specimens from Sart, and are perfectly colourless. They are exceedingly small, the base often not measuring more than the thousandth of a millimeter. That some idea may be had of their delicacy, it may suffice to state that it is not rare to find two or three of them superposed. If the observer turn the micrometric screw he can readily convince himself that they occupy different planes even in the extremely minute thickness of the thin sections. Thanks to the delicacy and the perfection of their forms, one may attempt, with some chance of success, to determine the crystalline type in which the mineral is to be classed. The minuteness, however, of its dimensions, and the impossibility of isolating it, impose the necessity of pronouncing with great reserve on the mineralogical nature of these remarkable microscopic twins to which I now for the first time call attention.

By the inspection of the outline and of the extremely delicate line that joins the summit with the obtuse angle opposed the observer may readily recognize hemitropical forms; and the two halves polarizing with complementary colours prove in their turn that these two parts have their optical axes placed as they should be in the case of a hemitropy similar to that which we find in the greater number of these twins.

This mineral constitutes, in the great majority of cases, twins by juxtaposition; however, some are found which are twins by penetration; those, for example, which cling together by their summits, recalling what one sees in certain twins of tridymite, mentioned by Vom Rath. The angles of these rhomboids, to judge them by approximate valuations, such as can be made by the microscope, are of 60°, 90°, and 120°. In other terms, these are the angles given by the hemitropies of the crystals of the rhombic system which have an edge of about 120°, and for which the hemitropy is made following the rule = Plane of hemitropy = a face of the prism of about 120°, that is to say, a dome, $3 \text{ P} \infty$ for example, the principal axis of the two individuals forming together an angle of about 60°.

This interpretation explains the heart, or geniculated, twins which are presented to us in the little prisms contained in almost every thin section of the whetstone, and of the regular groupings of the rocks of Sart.

In spite of all the details resulting from a minute study of these remarkable crystals, we must, however, confess that they are not sufficient to determine to what species of mineral they belong. We are here before one of the most difficult problems of petrography, that of identifying with a macroscopic species, crystals of such small dimensions as those which we have discovered, and which besides show characteristics which seem to bring them near to known minerals. Yet there is nothing to prove that these microliths are not a new species. The abundance of material that we have at hand, and the extraordinary development of these forms in certain specimens that we have endeavoured to analyze with a scrupulous care, authorize us to think that they ought not to be referred to augite; in truth, epidote offers points of resemblance for the colour and the twin; for we know that Kokscharow has found hemitropies of epidote resembling these we have here; but the other characteristics of epidote are too different to permit us to ascribe to it these little twinned prisms.

In order to dissipate the doubts raised on this point, I have examined the analogous forms given us by the mineralogists for the minerals of the class of silicates, and I have been struck with the resemblance between the twins of chrysoberyl and our little twin crystals. What, besides, adds a certain value to this consideration is, that chrysoberyl is found in crystalline schist, as, for example, at Tarakoja in the Ural Mountains, and Marschen in Moravia. Stratigraphical and petrographical studies, moreover, lead us in like manner to consider the whetstone that we are describing as belonging to the series that we designate as crystalline schists.

In terminating this micrographical part of the article relative to the whetstone, let me remark that the oligiste iron appears but rarely, and even then sporadically, in this rock, and that it appears more generally, and especially, in contact with oligistiferous slate, whose relations with the rock we have just described we will now briefly study.

At the commencement of this paper I drew attention to the fact that the whetstone appears almost constantly associated with the oligistiferous phyllade, in which it forms regularly intercalated strata. We have seen that these two rocks are perfectly adherent, as also that the foliation of the one is common to the other; now it remains to inquire whether their mineralogical composition and micro-structure cannot throw some light on the relations that exist between them.

Let us see therefore what data the microscopical analysis gives

us for the oligistiferous phyllades. Here we have as guide M. Zirkel, who examined some thin sections of the phyllade of Recht, which is definitively the same as that associated with the Belgian whetstones. My observations on the oligistiferous phyllade of Ottrez, Bihain, Viel-Salm, &c., agree in every point with those of M. Zirkel.

M. Zirkel finds that the red grains scattered throughout this rock are in fact, as Dumont had admitted, oligiste iron; that under the microscope they appear of a red colour, and the sections, though generally irregular, are, however, sometimes hexagonal. M. Zirkel attributes the red colour of the phyllade to the accumulation of lamellæ of this mineral. These lamellæ, as well as the other constituents of this rock, are enclosed in a micaceous substance, which constitutes the fundamental mass of the schist. The third constituent recognized by M. Zirkel is garnet, which appears in his preparations with the same characteristic marks that we have already seen in the whetstone. We would remark, however, that this mineral is far more abundant in this rock than in the slate. He makes mention besides of prismatic microscopical crystals, some of which are geniculated twins, and a fifth mineral composed of granules generally flattened, black and opaque, irregularly terminated, and which are less than 0·015 mm. He is inclined to regard them as carbonaceous particles so often found in black or blue schist.

We have but little to add to this excellent description of oligistiferous slate; the only additional element that we have yet recognized in plates of this rock is schorl, whose sections appear here like the sections of this mineral which we have examined in describing the whetstone of Salm.

If now we compare the results which M. Zirkel has obtained for the composition of the oligistiferous slate and those which we have noted in this communication, we shall remark striking analogies in these two rocks, which we were far from suspecting, but which perfectly explain the phenomena presented by their microscopic study. In both cases a micaceous substance constitutes the fundamental mass; there is the same structure, both contain garnet and small prisms quite identical, and in both schorl is present. The difference consists only in the fact that the slate contains lamellæ of oligiste iron and carbonaceous granules, while these two minerals are rare in the whetstone.

There yet remains an important geological question to be discussed: it has reference to the origin itself of the rocks. Let it suffice to remark that I have not met there any elements with traces of clasticity. On the contrary, everything seems to show that its essential elements are crystalline, formed *in situ*. Resting on the ensemble of facts which I have observed, stratigraphic as

well as petrographic, I am inclined to admit that the bands or zones of the whetstone are real layers imbedded in the Cambrian formation of the province of Liege, and that they were deposited in the same way as the adjoining slates, in the Cambrian sea, with the proper characteristics that make them differ, from the very moment of their deposition, from the sediments that furnish phyllades. Without denying that a metamorphic action has affected this mass, in a general way, I am inclined to think that this phenomenon alone has not been able to effect the concentration of the mineralogical elements that constitute the whetstone.

In conclusion, I add that this rare rock of Salm and the neighbourhood presents a mineralogical composition such as I have never found in any of the rocks ordinarily designated as razor-stones. I may be permitted here to thank MM. Richter and Dana for the information and specimens of whetstones they have forwarded to me.

II.—*Observations on the Structure of the Red Blood-corpuscles of a young Trout.* By W. H. Hammond, Esq.

The circulation of the blood in a young trout may be so plainly viewed under the microscope, owing to the great transparency of the fish, that it occurred to me it would be a very good subject for experimenting on to ascertain if the red blood-corpuscles contain a nucleus in their living state as they flow in the vessels. By getting the little fish in a suitable position, as it swam in a cell full of water, I was able to use an objective giving an amplification of over 300 diameters; with this power I could see the corpuscles where they flow, slowly and singly, very distinctly in the smallest veins. When the red corpuscles presented their broad surfaces, they had the appearance represented in Fig. 1, a central spot or nucleus, and a rim round the margin. I also had good side views of the corpuscles in the small veins, just at the point where they branch out of the larger ones; here the corpuscles were continually turning over, and at times one remained stationary for a little while; when the edge was exactly opposite to me, they had the appearance shown in Fig. 2, the central spot or nucleus clearly projecting on both sides of the blood-disk. I could also see, as the corpuscles rolled over, that their outer part is a cylindrical ring; a section of one would have the appearance shown in Fig. 3. These observations were repeated many times on young trout varying from a day to three weeks old.

Fig. 1.

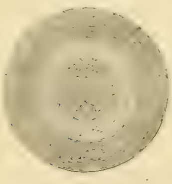
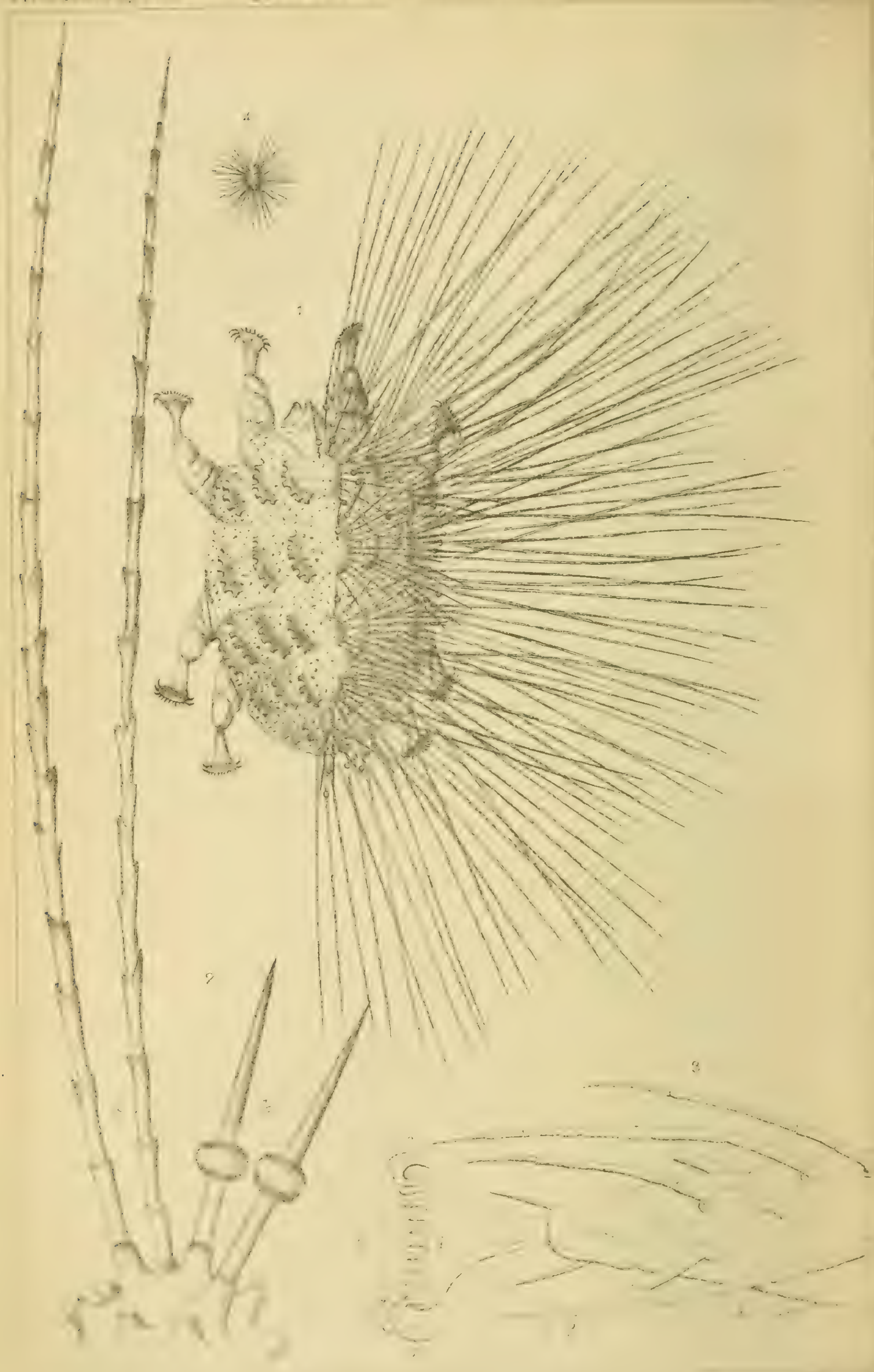


Fig. 2.

Fig. 3.

The question is important, for Professor Gulliver, F.R.S., in his paper entitled "Observations on the Sizes and Shapes of the Red Corpuscles of the Blood of Vertebrates,"* says, "In every animal, without any known exception, of this great division (Pyrenæmata), the red blood-corpuscle is characterized by the presence of a nucleus, which is plainly demonstrable in the majority of the corpuscles when examined on the object-plate under the microscope. Nor is the taxonomic value of this fact at all

* 'Proc. Zool. Soc.,' June 15, 1875.



M. Donnadieu ad nat. del.

Heterotrichus inæquarmatus, Donn.

affected by the old and still vexed question, as to whether the nucleus exists distinctly or at all in the corpuscle while it circulates within the living blood-vessels, or is formed only after its exposure to the atmosphere or chemical reagents. Many years ago De Blainville, Valentin, Henle, and others, and more recently Savory, supported the latter view; and the former was adopted by Mayer and Kölliker, to which Brunke has lately conformed. The subject cannot be entertained here; only it may be noted that I have satisfied myself of the substantial accuracy of Mr. Savory's observations on the blood-disks of some British Batrachians, but not of the validity of his conclusions therefrom, and that I have plainly seen in certain fishes the projections on the corpuscles, indicative of a nucleus, while they were flowing within the living blood-vessels."

The facts, described above, were shown in the living fish at a late scientific meeting, at Canterbury, of the East Kent Natural History Society, and were regarded with much interest by the members present.

III.—*A New Acarite.* By M. A. L. Donnadieu, D.Sc., Professor at the Lyceum of Lyons.

Plate CLXXXIII.

In the month of April, 1873, in emptying into a plate full of weak acetic acid * the contents of a collection from a sweeping net, I found an acarite which appeared to me to be quite new. It is difficult for me to give any exact idea as to its origin. The glass was full of acarites of all kinds, *Scirus*, *Trombidium*, *Gamasus*, &c., and with them a great many insects, among which the *Diptera* were most numerous, more especially those allied to the common fly.

With regard to the specimen which I found, which, in spite of

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EXPLANATION OF PLATE CLXXXIII.

Fig. 1.—*Heterotrichus inæquarmatus.* Entire animal seen from behind. The left half is represented without the numerous hairs which cover the body, in order to show the tubercles which support these hairs.

Fig. 2.—A tubercle very much enlarged, and showing the two kinds of hairs. *a.* Long and pointed hairs divided into segments. *b.* Short hairs with the peculiar spherical swelling.

Fig. 3.—Extremity of one of the feet. *a.* Tarsus. *b.* Edge of the cupuliform membrane deprived of hooklets. *c.* Two large internal hooklets. *d.* Nine small spatuliform hooklets. *f.* The three large external hooklets. *g.* hairs.

Fig. 4.—Acarite magnified twice.

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* See, for an explanation of this process of research, 'Recherches sur les Tétramiques,' par A. L. Donnadieu, 1875, p. 27.

all my search for others, was but that of a single individual, I believe that it is an undeveloped form (*hypopiale*) of *Gamasus*, which might very well have proceeded from one of the Diptera which I shall refer to. The mouth, too badly defined to have any significant value, the general form of the body, and, above all, the absence of reproductive organs, seem to me to confirm this idea.

I would observe that my description refers to the actual form of the individual, without in the slightest degree indicating what the ultimate appearances may be. I have called it *Heterotrichus inæquarmatus*, which name can be applied to the complete form when I am fortunate enough to obtain it.

The body, which is very transparent, is ovate; the *rostrum* makes a very slight bend forwards, through which one distinguishes only that which should be the *palpæ*. The inferior surface is flattened, the upper one is swelled out (*bombée*). The skin on the entire region of the body is granular, and presents grooves in the neighbourhood of the feet and rostrum.

On the dorsal face one sees a series of rounded elevations like little tubercles. At their level the skin is slightly brownish; they serve to support the hairs which by their nature justify the generic name that I have given the animal.

These hairs are, in fact, of two kinds. The one spiny at their ends seem formed of a series of joints, which fit one into the other. They are twice to three times the length of the body. They are comparatively slender, but are nevertheless rigid enough to give the animal the appearance of a body covered with sharp spines. The others are short, and terminate in a slender point; almost in the middle they present a very large vesicular swelling filled with a mucous-like fluid, which by its transparence contrasts vividly with the brownish tint which fills the rest of the hair.

The disposition and number of each of these hair-like processes on their little elevations of the surface are unimportant; but these latter are so abundant that the whole body disappears beneath the mass of hairs which cover it.

The feet, eight in number, are short and decidedly conoid. They differ very slightly in length, the anterior pair being slightly shorter than the others. Two pairs are directed in front, and two backwards. At the point of origin they sensibly approach each other.

Their mode of termination is the most remarkable point about them. The conical tarsus is terminated by a wide membrane capable of forming a cupuliform caruncula, on the lower border of which are placed hooklets. The latter are of two forms, and their appearance led me to give the specific qualification to the animal of *inæquarmatus*. The first are freely bent, as is the case in the majority of the species. They thin away from base to extremity,

and their curvature forms a more or less marked semicircle. Two are directed to the front and the external border (*le bond externe*). Three others are seen in the outer border, but they are directed backwards. Between these two series are placed the hooklets of the second form (*les crochets de la deuxième forme*). The latter are placed regularly upon the inferior borders of the tarsal extremity, and are nine in number. They are short, and their initial part assumes up to the point of its insertion a more or less spatular form. Towards their summit they curve brusquely upwards, and terminate in a very short conical point. They are all equal in their length, which does not exceed a third of the preceding ones.

Finally, the feet are covered with hairs analogous to the long ones on the body, but much shorter and more transparent.

By all the characters that I have pointed out, this acarite appears to belong to the *Gamasidæ*, to which certainly belong the adult forms represented in the present state of our knowledge by the undeveloped stage of certain Gadflies.—*Journal de l'Anatomie*, December 1876.

IV.—*On the Action of Chlorophyll in the Vine.*

By Giovanni Briosi, Engineer and Director of the Agricultural Station in Palermo.*

One of the grandest conquests in the realm of modern botanical physiology, since it concerns the most fundamental phenomenon of life, is, without doubt, the discovery of the assimilating function of chlorophyll by which it forms starch out of the carbonic acid of the atmosphere and water, under the action of the light. As is known, it was the work of Mohl, Gris, Böhm, Sachs, Nägeli, Kramer, Kraus, &c., which led to this discovery, which has often since been confirmed. Consequently it is at present generally admitted that the starch is, at least amongst the vegetable substances which are known to us, the primary form of the organic material of plants, out of which the laboratory of nature derives by transformations partly understood, and partly unknown to the chemist, all other physiological allied substances, as sugar, dextrine, inulin, cellulose, fat, &c.

In another work,† I have pointed out that the product of the assimilation process of chlorophyll in some plants cannot be starch,

* Translated from the Italian by W. R.

† Briosi, "Ueber normale Bildung von fettartiger substanz im Chlorophyll" ('Botanische Zeitung,' 1873, No. 20 and following ones); also 'Nuovo Giornale Botanico,' April 1875.

and demonstrated in fact that in the chlorophyll of the *Strelitziæ* and *Muscæ*, instead of starch, oil or fat is constantly formed, and that in these plants afterwards, out of those substances, the cellulose, and the starch itself (which, too, is found in some of their organs), &c., originate.

And these *Musaceæ* and the *Allium cepa*, in whose chlorophyll-grains Sachs could never detect starch, and where it is suspected that glucose is formed, are the only plants in which (to my knowledge at least) it is certain that no hydrocarbon is formed.

Since 1872, whilst studying what substances are formed in the vine, and what transformations they undergo, I often had occasion to observe, that in the chlorophyll-grains of this plant no starch is found, but the knowledge that this well-known and important plant had already formed the subject of the researches of the most distinguished scientific men deterred me from prosecuting my labours; and since then I had no opportunity of taking them up again, as during the last few years I have almost been taken away entirely from my studies.

Having been called upon towards the end of last autumn, by His Excellency the Minister of Agriculture, to occupy myself with a new disease of which we were warned in some vineyards at Favara (which disease has shown itself at present in the neighbourhood of Palermo as well, in a vineyard of Count Tasca, and which seems to threaten serious disaster to our wild vine), I recommenced my researches on the vine, of which, for the moment, I will state the following facts:

Up to the present, I have never been able to detect even the slightest trace of starch in all the vine leaves I have examined, either young or old, in different vineyards and different varieties.

The chlorophyll-grains of the vine, when treated with alcohol, potash, acetic acid, or iodine (usual method), appear more or less with hollows, but there never is the slightest indication of a starch reaction.

Holes and little gutters are also formed in the chlorophyll-grains, either under treatment with alcohol, or even with distilled water. When dry, and without applying any reagent, the chlorophyll-grains appear (uniform) without any holes or cavities.

The chlorophyll-grains, which are for several days placed in a saturated solution of bichromate of potash, appear mostly without holes, but have lost their homogeneousness, and often show in their interior more or less dark spots. On the other hand, I never found starch in the *mesophyll* of the vine leaves hitherto examined by me, with exception of the enclosure-cells of the stomata, where it is never wanting. A small quantity of starch only is found in the *vasi crivellati* and in the *strati amilacei of* Sachs, and in the ordinary fibro-vascular bundles.

Glucose, too, I have been unable up to the present to ascertain microscopically in the vine leaves, since I, once only, had precipitated some red grains of oxide of copper in but two cells; if afterwards there was found glucose, it was in such small quantity as to be totally insignificant. Of oil or fatty matter, either nothing, or an insignificant proportion, is found.

The only substance, however, amongst those determinable by the microscope, which is met with in abundance in the vine leaves, is tannin. It is found not only in the epidermal cells without chlorophyll, on both sides of the leaf, but also in all the cells with chlorophyll; nay, in the substance of the palissade (*palizzata*) cells of the upper part of the leaf, where, by the direct action of the light, the influence of the chlorophyll must be more energetic than anywhere else, tannin is most abundant.

From this, and other observations, I will not conclude as yet that tannin is formed in the chlorophyll-grains of the vine leaf, well knowing how daring such a conclusion might appear, inasmuch as the greater number of researches made with regard to the share held by the tannin substances in the vegetable economy, lead us to regard the tannin more than anything else as a secondary and lesser product, and one of those which, when once formed, change no more, and remain as inert substances in the cells in which they originated, without having any share in the formation of fresh organic substance. At any rate, from researches now undertaken, I hope soon to be able to say something more positive on this subject.

One more observation: It is at present generally admitted that the *libro tenero* is made up of the texture which is destined for the carriage of the protein substances, whilst the hydrocarbons and the fatty matters would be conducted through the *parenchyma*. This theory originated with Professor Sachs (to whom vegetable physiology owes so much), and rests mainly on the fact that in the elements of the first texture only albuminoid substances are found, and because chemists never have been able to find starch, otherwise than in an exceptional manner, notwithstanding that the degree of these triple (threefold) substances can be so very easily ascertained.

On another occasion * I have shown that in the *libro tenero*, and specially in the cribriform vessels, starch scarcely ever is wanting, and even that this starch, on account of its most minute formation, and of the peculiar construction of the said organs, seems well adapted to be carried from one part of the plant to another. At present, it is not without interest to know that, in

* Briosi, "Ueber allgemeines Vorkommen von Stärke in den Siebröhren" ('Botanische Zeitung,' 1873, No. 15 and following ones); also 'Nuovo Giornale Botanico Italiano,' April 1875.

the *libro tenero* of the vine, and particularly in the cribriform vessels, there is undoubtedly found besides starch, also tannin, and this in great abundance; this fact will help also to account for the physiological action exercised by this substance in the plant.

I shall soon publish the particulars of the researches alluded to in the present preliminary communication.

V.—*On the Changes of the Fixed Corpuscles of the Cornea in the Process of Inflammation.* By G. F. Dowdeswell, B.A.

Plate CLXXXIV.

Since the discovery by Von Recklinghausen of the immigration of pus-corpuscles into the substance of the cornea in inflammation, several observers have alleged that proliferation of the fixed corpuscles of that tissue also occurs; in other words, that the so-termed leucocytes are not entirely immigrant, but that some of them are formed in the inflamed tissues. It is stated by those who take this view of the process, that in a few hours after the establishment of inflammation the fixed corpuscles begin to alter, that their processes are partially retracted and thickened, their outline becoming more distinct, and that at a later period small spherical bodies appear in their substance by a process of endogenous cell-

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EXPLANATION OF PLATE CLXXXIV.

Group I.

Corpuscles of the Normal Cornea.

Fig. 1.—Two corpuscles, isolated, of a vacuolated appearance; nucleus indistinct, processes much anastomosing.

Fig. 2.—Two similar corpuscles.

Fig. 3.—A single corpuscle, showing reduplication of nucleus and nucleolus, and what might be taken for segmentation of its substance.

Fig. 4.—Two typical normal forms.

Fig. 5.—A single corpuscle, with very large and strongly defined nucleus.

Group II.

Corpuscles of a Cornea forty-eight hours after commencement of inflammation by application of Nitrate of Silver.

Fig. 6.—A group of fixed corpuscles (*c*) and wander cells (*w*). The latter are seen to be of diversified form and in an active state of cell-division. The appearances which the fixed corpuscles present are all paralleled in the figures of normal preparations, and, notwithstanding the activity of the inflammation, as evidenced by the state of the wander cells, there is no appearance of proliferation nor of anything abnormal in these.

Fig. 7.—A corpuscle with conspicuous nucleus and two wander cells (*w*) clinging to its processes.

Fig. 8.—Two corpuscles, the one vacuolated and with nucleus distinct, the other similar to Fig. 3, Group I.

formation; that with the progress of inflammation these changes increase, the corpuscles losing their stellate form, and assuming the character of endogenous mother-cells which divide by fission.

These observations have all apparently been made upon corneas excised and examined in serum or other fluid, or upon laminæ of corneas prepared by the gold method.

Cohnheim and others have denied that the changes are objective, and attribute all the appearances to an active immigration of leucocytes. A principal objection to this conclusion has been founded on the grounds that the observations commenced too late, when the asserted changes had already occurred.

In the ordinary methods of preparation, the appearances presented during the second and third day of the inflammation are such as might readily be conceived to arise from proliferation of the elements of the tissue; and it is unquestionably matter of great difficulty to determine with certainty whether this does occur or not. The purpose of the present note is to describe a mode of investigating these appearances, by the employment of which satisfactory evidence may be obtained that the process essentially consists in the penetration of colourless corpuscles (migratory cells), in a state of active cell-division, into the cell-spaces of the cornea, where they overlie and obscure the cornea-cells in such a way that, in preparations made by the usual methods, they appear to be incorporated with them. If, however, a method is employed by which the ground-substance can be destroyed (as e. g. by potash) and the corpuscles separated by teasing, it is shown that they are perfectly unaltered, the migratory or wander cells only undergoing cell-division; so that it is by the presence of the latter alone that the difference between a normal and an inflamed cornea can be recognized.

The appearances presented by these corpuscles in corneas prepared by the ordinary methods, when supposed to be undergoing proliferation, have been so often described and figured that they need not be further referred to here.

Methods adopted in these Experiments.—Inflammation was induced either by touching the surface with a fine point of nitrate of silver in the usual way (in which case the ensuing process arrives at its height in about forty-eight hours, and then gradually subsides, so that by the fourth or fifth day its effects have disappeared), or (when it was desired that the process should be of longer duration) by a seton of silk thread. The animal having been killed at the proper period, and its cornea excised and immersed in half per cent. solution of gold chloride for sixty minutes, and exposed in a light warm place, when sufficiently coloured a small portion of the inflamed part is placed in a solution of potash till the ground-substance is completely dissolved. Care is requisite to hit off the

exact point for this, a few minutes too much or too little rendering the preparation useless. If the time of exposure is too short, obviously the ground-substance is not wholly dissolved, and nothing is seen; if it is too long, the potash begins to act upon the protoplasm, and the corpuscles cannot be separated nor distinguished. It was found that, if the cornea was put into a 20 per cent. solution of pure potash cold, and then subjected to a temperature of 40° C., fifty minutes was the proper time required for the action of the potash.

When sufficiently acted upon, the cornea is transferred to slightly acidulated water, to stop any further action of the potash, then placed on a slide, if necessary teased out lightly, and preserved in glycerine.

In a preparation made by the above methods, a number of migratory cells will be apparent under the microscope, some of which are entangled amongst the processes of the fixed corpuscles. All these are in a state of active cell-division and assuming diversified forms, but are very readily distinguished from the fixed corpuscles by their being devoid of processes, of somewhat darker colour, and by their presenting a more opaque and solid appearance.* The fixed corpuscles, with their processes, show no alteration whatever. As may be seen from the Figures (Plate CLXXXIV., Group II.), the processes radiate from the bodies in a natural and symmetrical manner, and the ramifications are as perfect as ever. This would certainly not be so if segmentation had occurred; for in that case one side at least of each newly divided corpuscle would be devoid of processes. Nothing approaching to such a condition is ever seen. In inflamed preparations, as in normal ones, fixed corpuscles are occasionally met with containing two nuclei or a double nucleus; but this appearance is not often seen, and not more frequently in later than in earlier stages.

In conclusion, it may be stated that in the whole number of successful preparations of corneas which have been examined (amounting to upwards of twenty), no single instance has occurred in which any distinct appearance of segmentation can be made out. The most careful scrutiny of the preparations fails to detect any difference whatever, as regards their forms or aspects, between the fixed corpuscles of inflamed corneas and those of normal corneas prepared in a similar way; nor would it be possible to distinguish preparations of the two classes from each other, were it not for the presence of migratory cells in the inflamed structure.

In the drawings representations are given both of normal preparations (Plate CLXXXIV., Group I.) and of others at the most active period of inflammation (Group II.). These have all been most carefully drawn under the camera, each fibre and line being

* This is not adequately shown in the drawings.

W. West & Co. lith.

Corneal corpuscles.

Group 1, normal, — group 2, inflammatory.

actually copied as they appeared *in situ* in the field of view of the microscope, some processes and other bodies being omitted for the sake of clearness, and the peripheral members of the group sometimes brought nearer to the centre to save space. Numerous other preparations were made at all stages of inflammation, commencing with five hours, when little or no change was observable, up to five and seven days, when, in the case of inflammation induced by nitrate of silver, the effects had passed off, leaving no recognizable traces.—*Proceedings of the Royal Society*, No. 177.*

VI.—*Goodsir's Arguments on the Development of the Teeth of certain Ruminants.* By M. V. Pietkiewicz.

In a communication made to the British Association in 1839 Goodsir announced that he had discovered in the jaw of the calf and sheep the germs of incisor and canine teeth, and even of a molar, intermediate between an abortive canine and the ordinary molars which exist in these animals. Geoffroy Saint-Hilaire had already described abortive dental germs in the lower jaw of the baleen whale (*Balæna mysticetus*). Naturalists, partisans of the theory of Lamarck, and of Evolution, Darwin particularly, seized hold of this idea; and thus associating the discoveries of comparative anatomy and palæontology, this embryological discovery permitted the association of groups of animals which had before been separated.

Everyone knows the difference which exists between the dental formula of ordinary ruminants, as the ox and sheep, whose formula is I $\frac{0}{3}$ C $\frac{0}{1}$ M $\frac{6}{6}$, and the formula of the omnivorous pachyderms, the hippopotamus and the wild boar (le Sanglier), I $\frac{3}{3}$ C $\frac{1}{1}$ M $\frac{7}{7}$. But all authors have found the presence of superior canines in two or three genera of ruminants, the deer and the goat, which have a formula of I $\frac{0}{3}$ C $\frac{1}{1}$ M $\frac{6}{6}$, and the existence of a pair of very distinct upper incisors in the camel (*chameau*) and lama (*lamas*), giving the formula I $\frac{1}{3}$ C $\frac{1}{1}$ M $\frac{6}{6}$. According to M. Paul Gervais these latter had even two pairs of upper incisors, one of which disappeared in the adult, but was present in young animals, so that they would have this formula I $\frac{2}{3}$ C $\frac{1}{1}$ M $\frac{6}{6}$; this author does not doubt either that if the animal was examined at a younger age still, one would find a third pair of incisors in them, and thus that their dental formula would be related to that of pachyderms minus one molar: I $\frac{3}{3}$ C $\frac{1}{1}$ M $\frac{6}{6}$. Then, on the other side, the study of fossil species has shown that the *Dinotheriums* and the *Amphitragalus*, considered as ruminants of the group of *Chevrotins*, have seven molars

* Professor Huxley has kindly given permission for its reproduction here.—Ed. 'M. M. J.'

as the wild boars (*Sangliers*) have, that is to say the same number as the pachyderms. Thus, among the ruminants, we already know of fossil species having the same dental formula as the pachyderms, and of living species whose formula is almost identical; the discovery of Goodsir, by giving to ordinary ruminants, such as the ox and sheep, at a certain period at least of their lives, the same formula as that of pachyderms, permits us to associate these two groups. One set of naturalists sees in this one of the results of their hypothesis upon the unity of plan in nature. Another set sees in it a confirmation of their transformist theories, and explains the abortion of these organs by their non-usage, and the successive confirmation of this anomaly by "adaptation" and "heredity."

I was therefore surprised when, in endeavouring to verify an opinion which was so creditable to science, I found nothing whatever to justify it. In a long series of preparations made upon the embryos of the ox and the sheep from the earliest period of embryonic life to the period when the fœtus is 30 centimeters long in the sheep, not only have I never found the presence of follicles, but I have not even found *a trace* of the *epithelial lamina*, the beginning of all follicular development.

Goodsir's error was conceived through the false notion he had formed of the development of the follicles, and in the commencement of my investigations I had the same idea. In sections made properly at the anterior part of the upper jaw of the ox or sheep one finds in fact on each side of the median line an epithelial sac, which detaches itself from the buccal mucous membrane to bury itself in the jaw. The *mucous layer of Malpighi* uninterrupted forms itself an external lamina, whilst on its interior is found a polyhedric epithelium like that of the middle layers of the buccal epithelium. Thus formed this little sac appears to constitute the commencement of the follicle as Goodsir imagined it. But in continuing to make on the same jaw a series of sections going farther and farther from the anterior part, one sees the little sac lose its relations with the buccal mucus, and take the form of a circular canal for the mucus of the nasal fossæ. Soon appears around this canal a cartilaginous belt, then at its upper part is a pad (bourrelet) containing vessels, and then one has before him Jacobson's organ as Gratiolet described it. There is then nothing that can be compared even distantly to the germs of canines and incisors. If it is possible to conceive of Goodsir's error in face of the little epithelial sac produced by section of the buccal extremity of Jacobson's organ, one finds nothing to justify him in affirming the presence of three incisors, of one canine, and of one molar tooth in this region.—*Comptes Rendus*, March 12, 1877.

PROGRESS OF MICROSCOPICAL SCIENCE.

The Structure and Origin of Meteorites.—It may perhaps seem very strange to speak of the microscopical structure of the sun; but if meteorites have been formed in the manner suggested in Mr. Sorby's lecture, published in 'Nature' for April 5, such an expression may not be unreasonable. He there shows that the microscopical structure of meteorites, though in some cases analogous to that of melted lavas, is yet in a greater number of cases more like that of consolidated volcanic ashes. They have, however, some remarkable characters not yet found in any terrestrial rock, which indicate that they were formed under very special conditions. They frequently contain what were apparently originally small glassy spherules, which subsequently became more or less crystalline and devitrified. A large portion of some of these spherules is, however, still a true glass. The author shows that they are analogous to certain artificial furnace-products, but differ in such a way as to indicate that a melted glassy spray was projected into an atmosphere heated so nearly to its melting point that the particles could collect into spheres without being drawn out into long fibres, as happens when the spray is blown into a cool atmosphere, so as to form the natural *Pele's Hair*, or the analogous artificial furnace-product. Many other remarkable structures occur in meteorites, some requiring high magnifying powers; and the general conclusion deduced from them is, that meteorites were formed when the surrounding atmosphere was highly heated and subject to intense mechanical disturbances. Nearly all these remarkable peculiarities could be explained if they were formed under conditions like those now proved to occur near the surface of the sun, and the chief question is whether they are portions of solid matter, perhaps now projected into space during the intense disturbances known to occur on the surface of the sun, or are remnants of matter subjected to similar influences at a remote epoch when the conditions now met with only near the sun extended much farther out into planetary space. If this be the case, it is perhaps not too much to say that the microscope was never applied to a question of greater magnitude, and the important bearing of very minute on immensely great objects made more apparent.

Mr. Dallinger's Lecture on Monads at the Royal Institution.—On the first Friday evening of last month (May), the Rev. W. Dallinger, V.P.R.M.S., delivered a most important lecture on monads before the Royal Institution. The illustrations were given by means of the electric lamp so familiar to those who go to the Albemarle theatre, and they were in every respect admirable. The lecture, however, was in substance similar to Mr. Dallinger's excellent article in one of last year's numbers of the 'Popular Science Review.' He proved the marvellous changes of form seen in some of these species of monads to be continuous alterations which invariably ended in the production of the original type. This he did by the most wonderfully patient observations. He also proved—a most important point—that there

was a difference in the power of resisting high temperatures exhibited between the mature and young forms of monads. This fact is of infinite importance, as it tends to overthrow Bastian's notions.

The Diatom Earth of Richmond, U.S.A.—This subject has been discussed in an opening article (by Mr. C. L. Peticolas) in a late number of the 'American Journal of Microscopy.' It says that to the microscopist this deposit is a source of unfailing interest, whilst the most inexperienced in such matters, upon being shown the wonderful forms found in it, are struck with surprise and delight. In looking at these different forms, one is struck with the wonderful resemblance which they bear to things of every-day use, as among them may be found models of almost all the implements used by savages, whether for war, the chase, or in domestic life; witness, for instance, his stone hatchets, arrow and spear heads, knotted clubs, boomerangs, &c.; a catalogue of such matters used by civilized people would embrace plates, dishes, cups, saucers, gridirons, pins, balls, tops, spectacles, watches, anchors, dumb-bells, cannon, coin, musical notes, and many other articles—the investigator being constantly startled by the strange resemblance which hundreds of these ancient natural forms bear to articles used in our houses and workshops. Certain varieties, however, predominate, and their distribution varies with level and locality, the upper portion of the stratum being comparatively poor in forms, while they increase in number and variety as we descend to the middle, falling off again towards the bottom. The genus *Coscinodiscus* seems to characterize this earth, and of it there are dozens of varieties varying from the (microscopically) enormous *C. gigas* to the minute and elegant *C. subtilis*, which resembles closely a finely polished opal, requiring a lens of wide aperture and considerable power to show its revelations. *Orthosira marina* is abundant, whilst many beautiful forms of *Navicula* are found in every gathering. Amongst these we may note two kinds of *Pleurosigma*, one of which, *P. angulatum*, is a favourite test-diatom, and the other, which it is proposed to call *P. Virginica* (as it is the most common form of *Pleurosigma* in the Virginia earths), is remarkable for the beauty of its contour, which exactly copies a willow leaf, and the want of uniformity in its striæ, which are much coarser in the middle than at the ends of the valves. It is easily resolved with a $\frac{1}{4}$-inch objective, without the aid of oblique light. The genus *Triceratium* is also well represented by many beautiful varieties, the most interesting of which is *T. obtusum*, which can be resolved as easily as *P. Virginica*. *Isthmia enervis*, *Biddulphia Turmegii*, *Terpsinoe*, *Musica*, *Aulacodiscus crux*, *Navicula lyra*, *Gonphonema*, *Heliopelta*, *Asterolampra concinna*, *Asteromphalus Brookeii* and *Synedra* are comparatively rare. From the great variety of its species, and the wide range in the character of their markings, the Richmond earth forms one of the best and most interesting tests for the performance of objectives of almost every power. On some, for instance, the areolations may be seen with a simple triplet, magnifying 25 linear; on others a first-class twelfth or sixteenth of wide angular aperture, aided by all the modern refinements of illumination, is needed to show them.

Starch in Granules of Chlorophyll.—According to a contemporary, Böhm asserts that if light is sufficiently intense to induce assimilation in green leaves, it has the power to cause an immediate transfer of starch *from* the stem, where elaborated matters may be stored, *to* the chlorophyll granules. For this reason he believes that many observations hitherto made in regard to the immediate production of starch from carbonic dioxide in chlorophyll are untrustworthy. Such experiments should be made upon plants which have no starch already stored up, or upon detached leaves which contain no starch.

Reproduction in the Ascomycetes Fungi.—A paper on this subject has been contributed by M. Maxima Cornu to the 'Annales des Sciences' (1876, page 53), and it is given in lengthy abstract in a recent number of the 'Journal of Botany.' It states that the term "spermatia" has hitherto been applied to conidia-like bodies collected in special cavities, and thought to be incapable of germination. Tulasne had in some instances observed germination of bodies similar to spermatia, but where budding did not result, instead of doubting the perfection of his cultural methods, he believed he had to do with sexual elements, and to these he applied the special term. By adopting a system of culture somewhat similar to that made use of by Van Tieghem and Le Monnier in their researches on *Mucorini*, M. Cornu has succeeded in causing germination of many spermatia. The most satisfactory results were obtained when the nutritive liquid consisted of distilled water with 1 per cent. of sugar and 0·4 per cent. of tannin, though in a few instances simple water was the most advantageous medium of growth. With these results in hand, M. Cornu thinks it permissible to suppose that all spermatia are capable of germination if a suitable liquid can be found for each case; it becomes necessary, therefore, to consider the relations of spermatia to the similar reproductive bodies known as stylospores and conidia. Their main point of difference from stylospores resides in the fact that the membrane of the latter is usually double, while, unlike conidia, spermatia are collected in special cavities. M. Cornu thinks that terminology is here too exuberant, and he proposes the elimination of the term "conidium," referring thick-membraned conidia to a place among stylospores, and thin-membraned to spermatia. He also, following out Bonorden's suggestions, expresses his belief that certain Mucedines—e. g. *Verticillium*, *Acrostalagmus*, *Dendrochium*, &c.—are spermatia-bearing forms of Ascomycetous genera near *Hypomyces*; other Mucedines he would refer to *Peronosporeæ* and *Mucorini*. With regard to the function of spermatia, M. Cornu shows that, being very small and produced in great numbers, they are capable of causing wide diffusion of the species, the difficulty of germination being an additional advantage in diffusion, since the chances are considerable that before they reach a suitable nidus some time must elapse, during which they may be transported by the agency of winds, birds, &c.

The Lymphatics of the Joints.—Dr. Stirling states in the 'Medical Record' that Herr H. Tillmanns contributes an essay on this subject to the 'Archiv. für Mikros. Anat.' (Band xii.). It would seem that

the lymphatics of tendons, fasciæ, and serous membranes can very conveniently be injected by flexing and extending these parts. The joint of a newly killed dog was filled with a coloured fluid, and the limb flexed and extended, but no colouring matter entered the lymphatics. This would seem to show that absorption from the synovial surface takes place in a way different from that which obtains in the case of serous membrane. By the puncture method, however, Tillmanns easily succeeded in injecting with a 0·5 per cent. solution of silver or soluble Berlin blue, a very rich network of lymphatics lying immediately under the epithelium and also in the subsynovial connective tissue. This he did in the large joints of the ox and horse. The superficial lymphatics lie directly under the epithelioid layer, deeper than the finest capillaries, but superficially to the large arterial and venous branches. The author finds that the blood-capillaries do not project bare into the joint, but are covered by the epithelioid layer. No lymphatics were found in the villi of the joints. The superficial subepithelioid lymphatics communicate with very wide vessels lying in the subsynovial tissue, where the lymph-vessels are very numerous and not unfrequently surround the blood-vessels. The vessels can be most easily injected where the synovial membrane joins the base or cartilage. No lymphatics pass from the synovial membrane, either into the subjacent bone or cartilage. The microscopic structure of the lymphatics was studied by Stirling's method, viz. digestion in artificial gastric juice. It seems that the epithelioid lining of the lymphatics is directly continuous with the elastic tissue of the adjacent tissue, thus fixing the lymphatics. The lumen of the vessels will thus be kept patent by the elastic fibres, and may even be dilated when the fibrous tissue becomes swollen. This bears out some suggestions already made by Ludwig under normal circumstances.

Remarks on the Structure of Precious Opal.—Professor Leidy, according to 'Silliman's American Journal' for April, has an article in the 'Proceedings of the Academy of Natural Sciences of Philadelphia' for 1876, p. 195, on the microscopic structure of the opal of Queretaro, Mexico.

Structure of the Red Blood-corpuscle of Ovipara.—Mr. Gulliver sent a note on this subject to a late meeting of the East Kent Natural History Society. It is conceivable, he wrote, that there may be an essential difference between the corpuscles of batrachians and fishes; so that, granting the truth of his own and Mr. Hammond's observations on the presence of the nucleus in the living corpuscles of this class, the validity of Professor Savory's observations on the absence of the nucleus of the living corpuscles of frogs and newts would not be necessarily destroyed. And then the question would only be like that which was so much agitated upwards of a quarter of a century ago, concerning the structure of these corpuscles throughout the vertebrate sub-kingdom. At that time one party, following Hewson, declared that the nucleus is quite distinct; while another party, with

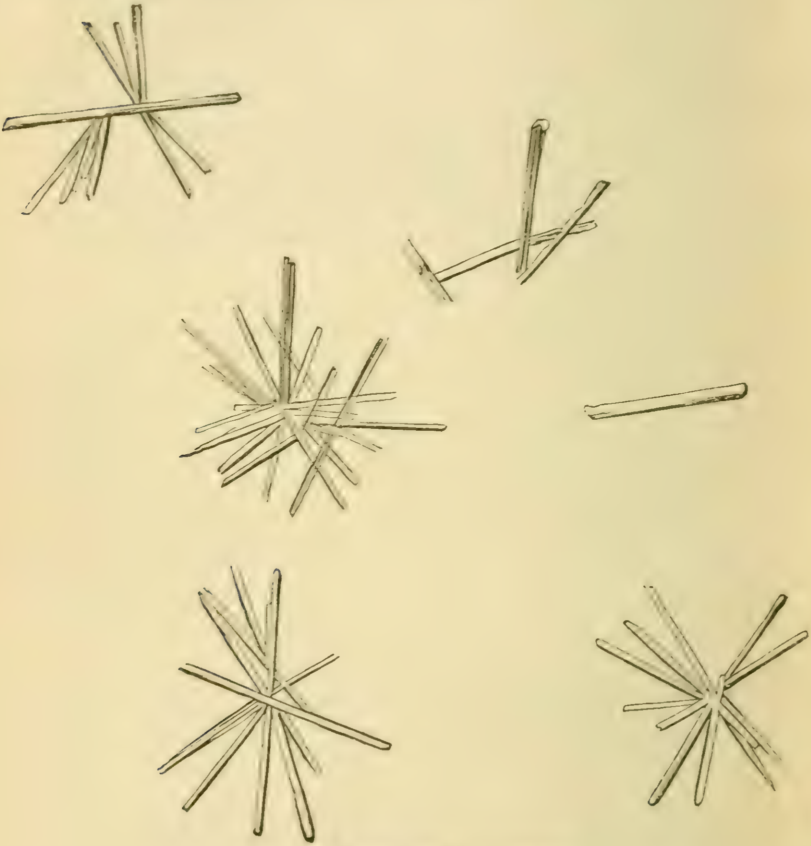
Dr. Young, Dr. Hodgkin, and Mr. Lister, maintained that there is no nucleus. But the subsequent researches of Mr. Gulliver had proved that the disputants on both sides were, as in the fable of the chameleon, both right and wrong; for the regular blood-disks of mammals are destitute of a nucleus, while those of the lower vertebrates are regularly nucleated. And hence his two great divisions of vertebrates —Apyrenæmata and Pyrenæmata.

The Blyborough Tick.—At the above Society, referring to the plates and engravings of this tick, lately published with descriptions in the 'Journal of the Quekett Microscopical Club,' and in 'Science-Gossip,' it was stated that specimens received from Blyborough had been forwarded from Canterbury to Oxford, and declared at that University to be identical with a species described and named *Argas pipistrellæ*, by Professor Westwood, in the 'Proceedings of the Entomological Society of London,' for the year 1872.

The Microscopical Active Principle of the Cobra Poison.—An interesting paper in which the chemistry of cobra poison is exhaustively dealt with, appeared lately in a paper termed the 'Analyst,' from the editor of which we have obtained the blocks used to print the figures over leaf. These representations are figures magnified 250 diameters of cobric acid, of which the following account is taken from an essay by Mr. W. Blyth, M.R.C.S., that appeared in the 'Analyst':—"On the 1st of January of this year, I succeeded in obtaining a crystalline, acid, extremely poisonous substance, which appears to be contained in the venom to the extent of 10 per cent.; this substance, there is every reason to believe, is the sole and only active principle. It may be obtained by coagulating the albumen with alcohol, filtering, driving off the alcohol at a gentle heat, concentrating the liquid to a small bulk, precipitating with basic acetate of lead, collecting the precipitate, washing it, and subsequently decomposing it in the usual way by SH_2, removing the sulphide of lead, evaporating to a small bulk at a gentle heat, and finishing the evaporation spontaneously or in a vacuum, or it may be obtained by coagulating and separating the albumen as before, shaking up in a tube with ether, removing the ether in the usual way, evaporating the ether off, redissolving in water and passing through a wet filter to separate fat, and evaporating as before; in either case the result is microscopic needles, dissolving in water with an acid reaction and possessing highly poisonous properties; they appear to be identical with the needles obtained by sublimation.

"For this substance I provisionally propose the name of *cobric acid*. I have not been able to go as yet any farther in the investigation of this interesting substance, for the simple reason that my two very small supplies are now exhausted, and I must wait for a third packet, but it will not be uninteresting to pause for a moment to consider what a terribly active substance this *cobric acid* must be, for supposing Nicholson's data are correct, and that the whole of the average quantity of the venom (that is 6 grains, containing 2 grains of solids)

is injected into a man, it then follows, since the solid residue contains 10 per cent. of *cobric acid*, that one-fifth of a grain would be fatal, so that we have here a rival to aconitia weight for weight in its power of destruction."



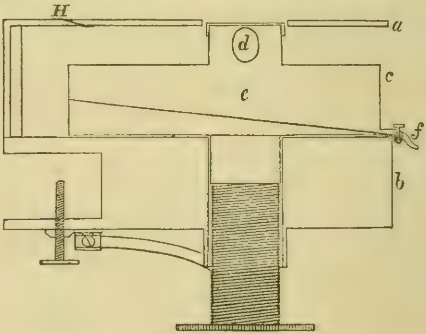
Cobric Acid magnified 250 diameters.

The Blood-vessels of Muscle under the Microscope.—Mr. W. H. Gaskell has recently presented a paper on this subject to the Royal Society, in which he describes the results of observations made on the living blood-vessels of the mylohyoid of the frog. He says he found that the mylohyoid muscle was the most suitable one for his purpose, it being easy to prepare it for microscopic observation without damaging the circulation through it, and, in fact, without even touching the muscle; whilst, owing to its thinness, the small amount of connective tissue in the neighbourhood of the vessels, and the absence of pigment-cells, it is possible here to measure with a micrometer eye-

piece the diameter of vessels more accurately and easily than in any other preparation. Upon placing this muscle under the microscope, without having previously touched the nerve, it is seen that the circulation presents much the same character as in the web, the median red-corpuscle stream with an inert layer on each side being plainly visible, although, perhaps owing to the manipulation, the arteries at first are slightly fuller and more dilated than the corresponding vessels in the web. The calibre of the smaller arteries does not, as a rule, remain for any length of time the same, variations taking place somewhat similar to what has often been described in the vessels of the web, but with this difference, that whereas in the so-called "rhythmic contractions" of the arteries in the web the artery appears to contract to a certain point and then to return to its original calibre or beyond it, in the arteries of the muscle the vessel appears to dilate from the normal calibre, and then gradually to return to that calibre or below it. These dilatations vary considerably in extent and are absolutely irregular in time, being much less marked both in frequency and extent in some frogs than in others, and depend, so it seems to him, probably upon some chance stimulation of the vessels, such as exposure to the air, &c. Upon direct stimulation of the web by means of the interrupted current there occurs a most marked constriction, not only of the arteries between the electrodes, but extending over the whole web, both during the stimulation and for some little time after the stimulation is over. He goes on to say, "Whether the arteries immediately between the electrodes contract, I cannot yet say; I can, however, affirm positively that there is no contraction of the smaller arteries situated but a slight distance from the electrodes, or if there is, it must take place in the very short space of time necessary for refocussing on the artery under observation, as in every case, as soon as I have been able to measure the calibre again, I have found it considerably dilated. Here, then, is a marked difference between the web and mylohyoid on direct stimulation. As to the effect of section of the nerve, I have always noticed that it is followed by a decided reddening of the corresponding muscle, the difference of colour being manifest, as previous to the section the two mylohyoid muscles are always equally pale. Upon closer examination, by first putting the muscle in position under the microscope and then cutting the nerve, it is seen that about five to six seconds after section the arteries dilate very rapidly, the dilatation soon reaching a maximum, in perhaps twenty or thirty seconds, and then gradually diminishing until the original calibre is reached, some four or five minutes after section—that is, the dilatation caused by section of the nerve is not a lasting one, but is exceedingly similar to that caused by slight mechanical stimulation of the nerve; for whether its peripheral extremity is pinched by a pair of forceps, or dipped into concentrated salt solution, or still more markedly when cut and torn by scissors and forceps, there always occurs after a brief latent period of a few seconds, during which there is no trace of constriction, a considerable rapid dilatation of the artery, which lasts but a short time, and then gradually gives way to a return to the original calibre, and is always accompanied by a more active very full stream, the inert

layer having wholly disappeared, and the red corpuscles being crowded together to the very edge of the vessel. Here, then, is another marked difference between the web and the muscle." *

Mr. Lewis' Freezing Microtome.—The adjacent cut represents this instrument, which Mr. Bevan Lewis, F.R.M.S., has described at some length in the 'Journal of Anatomy' (vol. xi.), and which is not so novel as he seemed to think at first. In fact, he states at the conclusion of his paper that he then became aware of a previously described instrument by Mr. Hughes; but he says that in his (Mr. H.'s) microtome, the spray is not so directly brought to bear upon the tissue, which consequently requires from five to eight times as long a period to freeze, with, of course, a corresponding increase in the loss of ether: this is of material import when absolute anæsthetic ether is employed. He states that "the instrument consists of three portions: (1) an ordinary Stirling's microtome; (2) a section plate; (3) a freezing and condensing chamber. The simplicity of the arrangement will, I trust, recommend its use amongst my fellow-workers in the department of cerebral histology. Reference to the accompanying woodcut will place the reader in possession of the plan upon which



this instrument has been constructed. The section plate (*a*) is riveted by a brass arm to the microtome (*b*). The freezing compartment (*c*) consists of a cylinder (*d*) and a condensing chamber (*e*), the latter being formed of brass with a sloping floor leading to the exit-tube, which is provided with a stop-cock (*f*). The cylinder is capped with tin-foil stretched across it, and has an orifice (*d*) through which the nozzle of the spray apparatus is introduced. In using this instrument it is only necessary to bring down the cap of the cylinder from one-fourth to three-eighths of an inch below the level surface of the section plate, and to place in it a section of brain of about the same thickness. The spray instrument is inserted at the orifice, and by the ordinary double elastic balls a free play of ether beneath the cap freezes the tissue in from twenty to thirty seconds or less. On withdrawing the spray instrument, the slight play of ether, still continuing from the remaining tension of the elastic ball, is utilized by being

* 'Proceedings of the Royal Society,' No. 176.

carried rapidly along the surfaces of the section blade, and then the finest possible sections may be cut with great ease. The consistence of nervous structures, when thus frozen, is really exquisite for section cutting, and the tissue remains rigidly adherent to the capped top of the cylinder. Perfect steadiness of the freezing chamber is ensured by soldering it to the microtome plug, and it can be readily removed from its position by throwing back the section plate, a movement allowed for by the hinge-joint (*H*)."

The Siliceous-shelled Bacillariæ in Diatomaceæ.—These are being described in the 'American Journal of Microscopy' (March and April),* from papers which originally appeared in the 'Lens,' and which were translations by Professor Smith, of Kützing's work on the *Bacillariæ.* Strange to say, however, there is no notice of either author or translator attached to the paper itself. But in another part an editorial note explains this fact. To those who are unfamiliar with the original work, this translation must prove of interest. The last passages in the April number contain a very decided but well-merited attack on Ehrenberg for his habit of disregarding the work of others in establishing species.

Reproduction of Rotifer vulgaris.—An American, Mr. C. F. Cox, has been studying this subject with some success. He says that "My attention was called to the process of reproduction by seeing, in the larger rotifers, an extra 'gizzard' below the one to which each individual seemed properly entitled, and by observing the independent movements of the imprisoned embryos. But a simple egg-shaped vacuole-like ovum is to be seen in every rotifer, even at its birth, I believe. Subsequently the embryo develops its ciliated lobes, its proboscis, its eyes, and its foot or leg, and for a short period before birth a slight ciliary movement may be seen, and a slow working of the gizzard. At this time its head is close to the gizzard of the parent, and the appearance is as if the fœtal rotifer were actually sharing the food of the mother and remasticating it. This, however, finally ceases, and the fœtus, generally with some difficulty, turns itself within the parent, in order to present its head first at the time of parturition. If the operation is interrupted, or the parent much disturbed, the fœtus may turn back again, and this vacillation is in many cases repeated several times before birth is effected. Some writers state that the nascent rotifers 'creep out of their envelopes, extend themselves, and put their wheels in motion, while within the ovary,' but I am convinced that motion of the 'wheels' is impossible at this time, both from the size and from the position of the young, and the rest of the statement quoted seems to me highly imaginary. The slight ciliary motion observable at this time is produced, I think, not by the large cilia upon the infolding head-lobes, but by a ciliary system lining the throat of the animalcule, analogous to the ciliary system which I have discerned in the throat

* By the way, there appears to be some irregularity of publication about this journal. We have only to-day, May 8, received the number dated April. Is it published at the end instead of the beginning of the month?

of Floscularia. From this motion's being seen so plainly in the nascent rotifer, I am inclined to believe that it is by this means that food is taken from the parent's supply, as already suggested. The movements of the fœtus do not seem to trouble the parent in the least degree, although she is, as usual, extremely sensitive to any external motion. The whirling of her cilia and the working of her gizzard are interrupted by the reproductive process only at the very instant of parturition. The ovarian sac opens into the cloaca, or rectum, of the rotifer, and the young is extruded from the anus, which is just at the lower edge of the upper segment of the foot-stalk or leg, and is what is rather indefinitely termed, by some authors, the 'contractile vesicle.' At the critical moment the parent draws herself violently together, so as to force the head of the young rotifer through the anus, and then the latter actively liberates itself and crawls away. At first it is somewhat awkward and undetermined in its movements, but, after creeping about for a few minutes, it attaches itself to some fixed object and opens out its ciliary wreaths, which it whirls as accurately and as gracefully as any *old* animalcule could do. Frequently a mother rotifer, containing a well-advanced embryo, also contains several partially developed ova, one of which may be seen to be undergoing a sort of segmentation or differentiation, the gizzard being about the first organ to make its appearance. I have several times seen a large rotifer, which had been killed in some way, lying drawn up into a rounded mass, in which a lively young one was making frantic but ineffectual efforts to break through the enveloping corpse and escape. This suggests the conclusion that the development of the fœtus, after it has reached a certain point, is dependent upon the parent only for food; and this supports my belief, already expressed, that the fœtal rotifer actually and actively feeds, and does not merely passively imbibe. On seeing so many rotifers containing young as I have happened upon in the last few days, I am astonished that their reproductive process has not been oftener the subject of observation and description than it seems to have been. *All* the rotifers I now see are in the interesting condition described, and yet, according to 'the authorities,' no males of *Rotifer vulgaris* have ever been discovered. Analogy, however, seems to indicate that this rotifer, like *Hydatina*, *Brachionus*, *Melicerta*, *Floscularia*, &c., is diœcious. The earlier steps in its mode of reproduction are, therefore, an inviting subject for investigation. By the way, why do Pritchard, Carpenter, and others, persistently describe and draw *Rotifer vulgaris* with spined or hooked margins to the segments of the foot-stalk or leg? I think I have never seen it with such segments. The foot-stalk, as far as I have observed, is simply telescopic, like that of *Actinurus*, and consists of more segments than are usually drawn or described—probably six. Can it be that there is a difference in these respects between the common rotifer of England and that of this country?"

A Tape-worm in a Cucumber (*!*).—It is stated that at a recent meeting of the Academy of Sciences, at Philadelphia, Dr. Leidy exhibited a specimen of a tape-worm said to have been taken from the

inside of a large cucumber. This was the first time he had heard of one of these worms having been found in a vegetable. It had all the characteristics of a true tape-worm, but belonged apparently to an unknown species. The ovaries, containing round yellow eggs, were confined to the anterior extremity of the segment. [The ova of the mature worm may have been deposited in the manure with which these plants are so freely surrounded, and it is remotely possible that some one of them may have got in through some crevice in the plant, and may then have begun its development as though it had got into a mammal's stomach. It is certainly difficult to understand.]

The Structure of the Brachiopoda.—This is very well given in a series of papers in the April and May numbers of the 'Geological Magazine,' by our most distinguished Brachiopodist, Mr. Thomas Davidson, F.R.S. King's, Hancock's, Owen's, Morse's, Gratiolet's, and Deslongchamps' views are fully discussed by the author.

Carboniferous and Permian Foraminifera.—The volume of the Monographs of the Palæontographical Society for 1876 contains an important essay by H. B. Brady, entitled "A Monograph of Carboniferous and Permian Foraminifera," the genus *Fusulina* being excepted. This has been well reviewed by a most distinguished Foraminifer authority, Professor T. R. Jones, F.R.S., in the May number of the 'Geological Magazine.' We give here the portion of interest to the microscopist:—"The 'Zoological Considerations,' of especial interest to the Rhizopodist, comprise a critical review of von Reuss' and Carpenter's classifications of *Foraminifera*, and a general comparison of the generic forms known in the Carboniferous strata with those now living. The conclusions arrived at are—1. The prevalent forms (except *Fusulina*) in the Carboniferous and Permian limestones do not belong strictly to either of the two sub-orders (*Imperforata* and *Perforata*) into which *Foraminifera* have been divided, but to intermediate types (especially *Trochammina*, *Valvulina*, *Endothyra*, *Nodosinella*, and *Stacheia*), neither invariably arenaceous nor uniformly perforate in their shell-texture. 2. In the modifications of these primitive intermediate types there are some varieties conspicuously sandy and imperforate, others essentially hyaline and porous; and these varietal peculiarities seem to have been transmitted as permanent characters, thereby originating the two parallel isomorphic series. 3. The porcellanous imperforate group (*Miliolida*) is of later creation, judging from negative evidence. 4. The Permian Rhizopod-fauna is much more limited than the Carboniferous, being confined to five generic types (*Trochammina*, *Nodosinella*, *Nodosaria*, *Textularia*, and *Fusulina*), representing, however, at least four distinct families of *Foraminifera*, which in the Carboniferous rocks are represented by fifteen genera." More than twenty genera and many species are described and figured, and after naming them in their order, Professor Jones concludes as follows:—"The exposition of the structure of *Valvulina* and *Endothyra* and their interesting subarenaceous allies, already noticed, and the discovery of the *Rotalinæ* (*Truncatulina*, *Pulvinulina*, *Calcarina*), and of the *Num-*

mulinidæ (*Archædiscus*, *Amphistegina*, and *Nummulina*), in the Carboniferous limestones, are some of the most important points in this excellent Monograph; and its value is greatly enhanced by eight elaborate Tables, special and general, showing in great detail the geological and geographical distribution of the fifty-eight species, according to their localities and stratal horizons in the many districts whence they were obtained. A perfect index for genera and species and their synonyms completes the volume."

British Fossil Bivalved Entomostraca of Post-Tertiary and Carboniferous Dates.—These have been thoroughly worked out and figured in sixteen plates in the 'Monographs of British Fossils,'* by Dr. G. S. Brady and Messrs. H. W. Crosskey and Dr. Robertson. Of it the 'Geological Magazine' (May) says:—"The classification of the *Ostracoda* (the special group of Bivalved Entomostraca treated of in this Monograph), according to the shape, texture, markings, and hingement of the valves, and the synopsis of their genera, based upon the anatomical characters of the animal, will be highly acceptable to the students both of recent and of fossil specimens; and indeed these admirable synopses are full of the latest information, derived from the researches chiefly of Dr. G. O. Sars, of Norway, and Dr. Brady himself. 'Of the 132 species of Ostracoda described in this Monograph, 24 may be considered to have been inhabitants of fresh or slightly brackish water, the remaining 108 being strictly marine species.' All except *Limnicythere antiqua* are known in the living state. Of the marine forms found in the Post-Tertiary beds there are lists given,—1. Of those now known as characterizing the Arctic seas and the northern coasts of Norway, Scotland, and America. 2. Those now extinct, or unknown in the living state. 3. Those found in the Glacial and Post-Glacial deposits of Norway. 4. Those found in the Glacial (and Post-Glacial ?) deposits of Canada."

The Carboniferous Entomostraca have been handled by Professor Rupert Jones, J. W. Kirkby, and G. S. Brady, in the same volume, and their observations extend only to "the Cypridinadæ and their Allies." "Some parts of the Mountain Limestones of various countries seem to abound in subglobular bivalve carapaces, and their loose valves, which approximate in character to various members of the Cypridinad group; some are also found in the Coal-measures; and others in the older Devonian, and even in the Silurian rocks. They are associated frequently with other Ostracodous valves, such as *Beyrichia*, *Leperditia*, *Cytheridæ*, and *Cypridæ* of various alliances. In this part of the Monograph we find 13 *Cypridinæ* (directly related to the existing *Cypridina*); 7 *Cypridinellæ*, 9 *Cypridellinæ*, 6 *Cypridellæ*, and 2 *Sulcunæ*, which are genera arranged artificially to receive several forms of carapace varying by gradational differences from the valves of the known *Cypridina;* 2 *Cyprellæ;* 1 *Bradycinetus;* 1 *Philomedes;* and 2 *Rhombinæ*, of which much the same may be said as of the foregoing; also 4 *Entomoconchi*, 1 *Offa*, and 3 *Polycopes.* The definition of the true *Cypridinæ*,—the true allocation of the

* Published by the Palæontographical Society, vol. xxviii.

several species placed by De Koninck under *Cyprella*, *Cypridella*, and *Cypridina*,—and a more exact interpretation of M'Coy's *Entomoconchus*, are (besides many new species) the chief novelties of this memoir, which is illustrated by five plates (by George West) very full of excellent figures of these small fossils."

Reproduction of Ulothrix zonata.—In a series of most valuable abstracts of German botanical papers that Mr. S. Le M. Moore is giving in the 'Journal of Botany' (May), appears the following, which is taken from a paper by Dr. Arnold Dodel in 'Pringsheim's Jahrbucher für Wissenschaft. Botanik' (vol. x. p. 417):—*Ulothrix zonata* has spores of two kinds—viz. 4-ciliated macrozoospores produced either singly or two together in the mother-cell, and 2-ciliated microzoospores arising several together in each mother-cell. Sometimes the two spore-forms are found in neighbouring cells of a thread, but they usually have distinct periods of activity, autumn and winter being favourable to the formation of macrozoospores, and spring and summer to that of microzoospores. The latter copulate and form resting zygozoospores, a fact which sets Areschoug's position beyond cavil; but the strangest thing of all is that those individuals which fail to copulate are like the macrozoospores in having the power of immediate asexual reproduction. This most remarkable observation, which its discoverer regards as furnishing a transition state between sexual and asexual generation, comes to some extent to the timely support of the Strassburg school, who deny that the fact of germination is sufficient proof of the asexuality of spermatia. Several figures are given showing polymorphism of the threads and of the zoospores; between the two forms of the latter there are all kinds of transition, the only absolute distinction being based on the number of cilia. Further, it has long been known that microzoospores sometimes germinate while still in the mother-cell, and Dr. Dodel has seen some of them degenerate in this position without budding. Dr. Dodel agrees with Pringsheim that copulation of microzoospores is the morphological type of sexual reproduction. As for the zygozoospore, which, germinating after its period of rest, produces, not a thread of cells but a variable number of zoospores from which the threads arise, it is regarded as an independent new sexual generation, so that we have in *Ulothrix* true alternation of generation. Dr. Dodel points out the affinity of *Ulothricheæ* to *Volvocineæ* and *Hydrodictyeæ*, but he is too prudent to dogmatize on the subject of classification. He holds, however, that the facts he has discovered afford strong support to the theory of evolution, as they show how (morphologically, of course) an asexual cell may become endowed with sexual properties.

Microscopical Contents of Foreign Journals.

Archiv für Mikroskopische Anatomie, 13 Band, 4 Heft (continued from last number of 'M. M. J.').—On the Cell-formation which occurs in the Connective Tissue of Muscles, by Walther Flemming. This is a paper illustrated by three very good plates. It treats

exhaustively of the subject of the structure of the connective tissue. The author deals principally with molluscan structures, giving those of *Mytillus edulis* and *Anodonta piscinalis* very fully. He makes out connective tissue to be a far more complex structure than it is generally believed to be, and his preparations, which are capitally drawn, bear him out. The preparations have been mounted in various ways. He has used, for example, alcohol, bichromate of potass, turpentine, glycerine, and osmium. For injections he has used Prussian blue and picro-carmine. The most important point he shows is that of the relation of the so-called schleim-cells. The memoir covers fifty pages. —There is also a short paper, by Herr Fr. Meyer, on preservative fluids for microscopic objects.

Reichert and Du Bois-Reymond's Archiv (January).—Carl Sachs describes and figures the terminations of nerve-fibres in certain tendons.—F. Boll's article on the Savian vesicles found in the torpedo about the nasal orifices and between the external edges of the electrical organs and the limb-cartilages, is very interesting, because he demonstrates the existence in their epithelium of spindle-shaped cells corresponding in character to those so commonly found in special sense organs.

The Zeitschrift für Wissenschaftliche Zoologie, vol. xxvi. part 2.—In this Herr Repiachoff continues his contributions on the Chilostomous Bryozoa, giving many interesting particulars about the development of the amphiblastic ovum of Lepralia and Tendra.—Herr Ludwig Graff describes the anatomy of the Sipunculoid *Chætoderma nitidulum*.—Dr. Hubert Ludwig writes on the interesting Gastrotrichous Rotifers, established as a separate order by Metschnikoff.

NOTES AND MEMORANDA.

Is Vision with the Microscope Finite or Unlimited?—A paper on this subject appears in the 'Boston Journal of Chemistry,' and is evidently written by one who is accustomed to microscopical research. We give it in full as follows:—The question of the limits of visibility is an eminently practical one, of great interest to all microscopists and physicists. On this question Mr. Sorby says: "The highest powers of our best modern microscopes, he [Helmholtz?] assumes, will enable us to see objects an eighty-thousandth part of an inch in diameter." This sentence hardly represents Mr. Sorby's position. After referring to Helmholtz's principles of interference fringes, or diffraction, he says, "It appears to me that we cannot do better than to adopt these principles in forming some conclusion as to the size of the smallest object that could be seen with a theoretically perfect microscope. Looked at from this point of view alone, with a dry lens this could not be less than one 80,000th of an inch." This

passage, it will be at once seen, is limited to the "*dry* lens," and while he says the "smallest object," the context shows that he means the separation of lines, and not a single object, for he at once goes on to show that closer lines may be separated by the use of blue light and immersion objectives, and also says, "The size of the smallest bright point that can be seen depends on entirely different considerations, and might be considerably less." All these speculations of Sorby and Helmholtz (and Abbe may be included) are based on theoretically perfect microscopes. (In this case the "microscope" means the *objective*, the all-important part of the instrument.) Now who ever saw a "theoretically perfect" microscope? Who can ascertain, that one is theoretically perfect? How can it be ascertained that one is perfect? The only possible way of measuring the approximation towards perfection is by the performance. So long as the performance of the best microscopes falls short of what a theory says is possible, the theory may be accepted as correct; but when the microscope has done *more* than theory says is possible, theory must be in fault. For years microscopes have been made, and are in use, that do more than Helmholtz's theory will allow. The difficulty with Helmholtz and Abbe is that they had not seen and experimented, in 1872, 1873, and 1874, with all the microscopes that had been made at that time, but only with such German instruments as came in their way; and that made their theories to agree with the performance of *those* instruments. That the theories are wrong is proved by the fact that Nobert's lines, finer than 112,000 to the English inch, have been seen repeatedly by numerous observers, whereas Helmholtz fixes the theoretical limit at 110,000. On the other hand, as yet no lines so fine as 114,000 to the inch have been seen. Nobert has ruled lines that he claims are 224,000 to the inch. Until something finer than 112,000 is actually seen, it must be an open question whether the failure is the fault of the microscope or of the ruling. Nobert himself has not seen his own finer lines, and always pronounced it impossible to see any finer than 80,000 to the inch, until he saw 95,000 to the inch with a Tolles' immersion lens. The writer saw 90,000 to the inch with a dry lens more than ten years ago. As to the size of a single object which may be seen, there is but little known. The limit is undoubtedly in the perfection, or rather want of perfection, in the microscope. The best experiments in this direction have been made by Mr. W. A. Rogers, of the Cambridge observatory. Various writers have assigned different values to the angle at which an object can be seen, varying from 6″ to 120″. This is, of course, a physiological matter. Mr. Rogers says, "Even the smallest value named is much too large. I will at any time undertake to rule a single line one 30,000th of an inch in breadth, which can be seen the distance of seven inches from the eye. This corresponds to an angle of about 1″. Comparing minute particles of matter which can be *seen* under a Tolles' $\frac{1}{10}$th objective with those that can be *measured*, in the way indicated above, there is every reason to suppose that the limit of visibility falls beyond one 400,000th of an inch. But that light is of 'too coarse a nature' to enable us to see particles of matter as

small as one 200,000th of an inch is a conclusion which can be refuted without the slightest difficulty." A few years ago Mr. Huxley said in substance, at a meeting of the London Microscopical Society, that if the opticians could not supply microscopes that would enable one to see spaces between objects one 100,000th of an inch apart, naturalists were at the end in that direction of their work. It was replied that American and London opticians had already supplied instruments that had separated lines but one 224,000th of an inch apart.

CORRESPONDENCE.

The late Professor Ch. G. Ehrenberg's Researches on the Recent and Fossil Foraminifera.

To the Editor of the 'Monthly Microscopical Journal.'

Sir,—The following observations on Dr. Ehrenberg's researches may not be uninteresting to your readers.*

Amongst the most enthusiastic observers and voluminous writers on microscopic organisms, Dr. Ehrenberg stands pre-eminent. By the end of the year 1838 he had reduced to order the multitudinous specimens of recent and fossil Microphytes and Microzoa which he had either collected, with Dr. Hemprich, in the East (Egypt, Dongola, Syria, Arabia, and Abyssinia), or had received from numerous correspondents.

In the 'Transactions of the Berlin Academy of Sciences' for 1831, 1832, and 1838, Dr. Ehrenberg published the results of the researches made on Corals and associated animals by Dr. Hemprich and himself in 1823–25 among the islands and coral-banks, and along the coasts of the Red Sea. In this memoir, after reviewing the systems of classification adopted by his predecessors, he separated the Coral animals into *Anthozoa* (flower-animals) and *Bryozoa* (moss-animals); and the former he divided into *Zoocorallia* (comprising *Polyactinia*, *Octactinia*, and *Oligactinia*), and the *Phytocorallia* (comprising *Polyactinia*, *Dodecactinia*, *Octactinia*, and *Oligactinia*). Altogether he enumerated 386 living species, of which 110 he had himself observed in the Red Sea. The range of Corals and their occurrence in the fossil were also noticed.

The classification here alluded to has been superseded by others based on a still more intimate knowledge of the structure and physiology of the Cœlenterate groups—*Hydrozoa* and *Actinozoa;* whilst the classification of his "*Bryozoa*" (*Polythalamia*,† *Gymnocorœ*, *Thallopoda*, and *Scleropodia*), mingling *Foraminifera* and *Polyzoa*,

* These remarks are based on some critical notes on Ehrenberg's species of Foraminifera in the 'Annals and Mag. Nat. Hist.' Ser. 4, vols. ix. and x.

† Ehrenberg's "*Polythalamia*" (divided into *Monosomatia* and *Polysomatia*) consist of *Foraminifera* with some *Polyzoa*.

could not greatly assist zoological investigation. Some interesting conclusions, however, were arrived at, valuable and true in the main,—namely, that the same kinds of *Foraminifera* occur both recent and fossil; that, nevertheless, each set of strata has more or less decidedly its own special group of Microzoa; and that Chalk in particular, and probably most limestones and calcareous marls, are largely composed of *Foraminifera* (*Polythalamia*, Ehrenb.). Thus these minute organisms, with *Coccoliths* (*Morpholites*, Ehrenb., in part), appear to be the main constituents of the White Chalk. Although even *recent* forms of Microzoa are found in the Chalk, Ehrenberg warns us that these lowly creatures only go to prove that this, like many other calcareous rocks, is a "Halibiolith," or marine deposit of organic origin; and not that the Cretaceous and Recent periods have been closely linked by identity and continuity of high grades of life.*

Amplifying with his own increased knowledge the already published observations on the persistence of low orders of life, Dr. Ehrenberg, having studied some living *Foraminifera* of the North Sea, at Cuxhaven, contributed in 1839 an interesting memoir to the Berlin Academy, figuring two living species (*Polystomella striato-punctata* and *Nonionina umbilicata*) with great exactness, as well as some obscure forms, which he found in both the living and the fossil state.† This memoir is given in English, with the original plates, in Taylor's 'Scientific Memoirs,' vol. iii., art. xiii.

In 1843 several highly magnified figures of minute recent *Foraminifera* from America were treated of and illustrated by Ehrenberg in the Berlin Academy Transactions for 1841.

Dr. Ehrenberg's memoir "On the muddy deposits at the mouths and deltas of various rivers in Northern Europe, and the Animalcules found in these deposits" ‡ was noticed at large in the 'Quart. Journ. Geol. Soc.' vol. i. p. 251, &c., as illustrative of the influence of microscopic life (chiefly Diatomaceæ) on recent and fossil stratified accumulations. Few can now recollect the astonishment with which geologists received in 1836 the assertion that large masses of rock, and even whole strata, are composed of the remains of microscopic animals and plants; § but this assertion has been confirmed and extended, largely by Ehrenberg's further labours, and we now recognize many "Halibiolithic" deposits and Diatomaceous earths.

In the 'Abhandl. Berlin Akad.' for 1847, many extremely minute *Foraminifera*, occurring in wind-dust on different occasions, in several parts of Europe, are described and figured. They form part of the curious gatherings of invisible things that wind-storms make and disperse in their whirlings over the surface of the earth,—sweeping the sea-shore, sand-bank, and dry river-bed, the volcano, the desert, and

* 'Quart. Journ. Geol. Soc.' vol. xxviii. pp. 122–124.

† The late Mr. Thomas Weaver, F.R.S., in the 'Annals and Mag. Nat. Hist.' 1841, and in the 'Philos. Mag.' of the same year, gave a full abstract of two of Ehrenberg's memoirs (read in 1838 and 1840) above mentioned, together with an appendix touching the researches of Alcide d'Orbigny on the *Foraminifera* of the Chalk of Paris.

‡ From the 'Abhandl. k. preuss. Akad. Wissenschaft. Berlin' for 1843.

§ 'Proceed. Geol. Soc.' vol. iii. p. 62.

the ploughed field, for organic and inorganic particles, and winnowing its dusty harvest over distant and far different areas. These tiny Foraminiferal waifs, potent witnesses of the path and doings of the wind-storm, being figured by transmitted light only, like those of 1841, teach little as to genera and species.

In these memoirs, and in shorter collateral notices in the 'Monatsberichte' of the Berlin Academy of Sciences (namely, for 1838, 1840, 1844, 1858, &c.), Ehrenberg treated of numerous *Diatomaceæ* ("*Polygastrica*"*), *Polycystina*,† *Foraminifera* ("*Polythalamia*"), Spongoliths, Geoliths, Phytoliths, and other microscopic organisms, which he had found, either recent (especially in the Red Sea, the Mediterranean, and the North Sea), or fossil in numerous deposits of various ages, such as the Mountain-Limestone, Oolite, Chalk, Tertiary, and Post-Tertiary strata. Some few of the recent and fossil species referred to in these memoirs were figured by him in the 'Abhandlungen' for 1838 and 1839; but it was not until 1854 that Ehrenberg was enabled to fulfil his earnest and laudable desire to give to the world faithful and manifold portraits of the well-prepared and almost innumerable microscopic objects on which his published opinions had been founded. In 1854 the crowning of his favourite labour was accomplished in the publication of the 'Mikrogeologie,' with the recognition and aid of the State. In this grand work, beside multitudes of fossil *Diatomaceæ*, *Polycystina*, Spongoliths, &c., the long-looked-for *Foraminifera* were depicted, from his own drawings, with the best artistic skill, with loving care and right royal liberality. There are 4000 figures, in great part coloured, and all, except plate 40, magnified at least 300 times linear.

With regard to the zoological determinations of *Foraminifera*, there is a great discordance between Ehrenberg and other Rhizopodists; nevertheless, taking a broad view of the results of his laborious, if not accurately discriminative, work among the fossil and recent *Foraminifera*, we may fully acknowledge his having shown that several living species are also to be found fossil in Tertiary and Cretaceous deposits. Throughout the 'Mikrogeologie' there appear numerous persistent forms, belonging to the Cretaceous, Tertiary, and Recent periods. These his experienced eye readily detected; and in many instances his lists show their relationship; but, for some occult reason, he failed generally to characterize them by description and nomenclature, though often grouped naturally on his plates. As with his classification of the *Foraminifera* among his "Bryozoa" (1839), so with his 'Mikrogeologie' (1854), he failed to seize the clue to the right understanding and disentanglement of these many-featured Rhizopods. Ehrenberg's truthful plates, however, supply the rhizopodist with a storehouse of beautifully prepared specimens, mostly seen by transmitted light; and from these, for by far the most part, good and useful conclusions can be drawn, as from fresh specimens, except that, being viewed only as transparent objects, with but little

* The "Polygastrica" of Ehrenberg, or "Infusoria," comprise *Infusoria*, *Diatomaceæ*, *Desmidiaceæ*, and some *Gromidæ*.

† Ehrenberg's *Polycystina* comprehend the *Polycystina*, *Acanthometrina*, and *Thalassicollida* of later authors, by whom the whole group is termed *Radiolaria*.

perspective, and rarely with both faces of the shell, they too often fail to satisfy the student, though the artistic labour bestowed on them has been exact and conscientious.

(*To be continued.*)

I remain, Sir, yours, &c.,

T. RUPERT JONES.

MR. ARCHER'S GENUS HYALOSPHENIA.

To the Editor of the 'Monthly Microscopical Journal.'

READING, *May* 5, 1877.

SIR,—Mr. Archer, in his "Résumé of Recent Contributions to our Knowledge of Fresh-water Rhizopoda" in the current number of the 'Quarterly Microscopical Journal,' refers "a lobose, monothalamian sarcodine" to the genus *Hyalosphenia*, instituted, with questionable propriety, by Stein, and accepted by Mr. Archer, though with obvious hesitation.

Permit me to say that the so-called *Hyalosphenia lata* recently detected by E. Schultze is *neither good as a genus nor new as a species*, having been briefly described and correctly figured in your own Journal so far back as December 1870, under the name of *Difflugia ligata* by

Yours truly,

J. G. TATEM.

LORD S. G. OSBORNE'S EXHIBITOR.

To the Editor of the 'Monthly Microscopical Journal.'

SIDMOUTH.

SIR,—As I find that my former letter to you on the subject of an instrument to facilitate the exhibition of the Diatomaceæ, and other objects, requiring very oblique light when examined with high powers, has attracted the attention of some good observers, will you kindly permit me to offer a few more words on the subject, as I am anxious to prevent any disappointment to those who may try it.

I find, and have informed Mr. Curteis, that all the apertures necessary, may be with ease cut on one disk. If a line is drawn through the centre of a disk, crossed by another at right angles, a good workman will with ease cut four apertures, one on each of these lines. They should be one-tenth of an inch from the point at which the lines intersect. If so cut, when the disk is revolved, each aperture will in turn come to the same position as regards the slide on the stage; they will not in any way interfere with each other. This plan saves a great deal of trouble, and enables the observer to try the effect of each aperture on any object, with the greatest ease, and no disturbance of any part of the instrument.

I always now use four apertures so cut—a fine slit, and three triangles punched in different positions as regards the centre of the disk; in the case of each, taking care that their illuminated edge should be the one-tenth of an inch from the centre.

It much facilitates the use of the Exhibitor, if, before this disk is

put in over the small drum lens, the mirror is worked until it gives a reflexion of the lamp—*strong* on the edge of its diameter farthest from the lamp.

I use as lamp, and most strongly recommend the following simple plan. On the sliding tube which carries the shade of an Acland lamp, I slide a tin shade blackened, covering the whole chimney. In this shade is a circular aperture opposite the flame, against which I fix an ordinary condensing lens; a tin cap slips over this with an aperture $\frac{1}{2}$ inch in diameter, at the base of a cone projecting $2\frac{3}{4}$ inches; at the mouth $1\frac{1}{2}$ inch in diameter. I have two small cones to pass into this, as diaphragms; one with small circular aperture, the other a slit the size of the flame. I find it best to blacken all parts of the tinwork. I have given Mr. Curteis a drawing of the arrangement.

I have, since I wrote to you, tested the power of the instrument in every possible way; it has never failed me. I can get diatoms brilliantly illuminated on perfect black ground, and on any shade up to a soft grey light. With the $\frac{1}{2}$ inch of Ross, the Type-Platten is a most beautiful study. With the highest objectives, I, with ease, get all the definition of which they are capable, with very little trouble.

Let me add, I have arrived at the conclusion there are some—daily I read of more—individuals whose eyes must be constructed after a fashion very different from my own, and that of anyone I ever met with. Their crystalline lenses must have been by nature gifted with a power of correction which counteracts any and every shortcoming in any object-glass. To them "the screw-collar" is a superfluity; they have a special visual power which adapts itself to the thickness of any covering glass. They have a peculiar power of penetration by their own eye-piece which supplements in the most extraordinary way the eye-pieces of the best opticians; to resolve a Pellucida into hemispheres with a $\frac{1}{4}$ inch of Ross is an easy thing!

I must confess I envy these most highly gifted men. I have worked hard at Diatomaceæ with the best powers of the best makers. I have used good, expensive sub-stage illumination, as well as some months' work with my own contrivance, I can make nothing of Pellucida beyond the beauty of its outline; I can with ease make out the longitudinal and transverse lines of the larger Rhomboides, with their intersection; the small Rhomboides with some care gives me one set of lines *well*, the other faintly; Crassinervis beats me.

The best tests of good magnifying power with penetration for high powers, are, to my mind, good specimens of Versicolor and *A. trilingulatus;* an object-glass which shows the full structure of these beautiful objects, I hold to be next to perfect, especially when seen on a black background. I shall be most glad if any of my brother microscopists are more successful than I have been with the Exhibitor; I shall be quite content if they meet with my own success. Nature has only given me the ordinary eye, now old; younger men of gifted eyes, may, for all I know, spot Pellucida with the Exhibitor; I shall hear of it with satisfaction, yet with envy.

S. G. Osborne.

PROCEEDINGS OF SOCIETIES.

Royal Microscopical Society.

King's College, *May* 2, 1877.

H. C. Sorby, Esq., F.R.S., President, in the chair.

The minutes of the preceding meeting were read and confirmed.

A list of donations to the Society was read by the Secretary, and the thanks of the meeting were voted to the donors.

The Secretary read the following letter, which had been received from C. J. Lambert, Esq.

3, Queen Street Place, Upper Thames Street,
London, *April* 24, 1877.

Sir,—My father, by his will, left a sum of 25,000*l.*, which he requested me to distribute among persons in his employ, and in gifts to scientific societies, in such manner as I should think fit.

I have the pleasure to inform you that I propose appropriating to you, out of the legacy, a sum of 500*l.*, and I enclose a legacy receipt, which I will thank you to sign and return to me, and I will then forward you a cheque for the amount.

I remain, yours, &c.,
C. J. Lambert.

The Royal Microscopical Society,
King's College, Strand, W.C.

P.S.—I have been induced to appropriate this sum to your society at the suggestion of one of your Fellows, Mr. John Badcock.

C. J. L.

He also stated that the money had been received by their Treasurer, and would be invested with the other property of the Society. He had only further to propose a special vote of thanks to Mr. Lambert for his munificent donation, and all would agree that their thanks were also due to Mr. Badcock for his very useful intervention.

Votes of thanks were then put to the meeting, and carried by acclamation.

The President said, that before proceeding to that for which they were more particularly assembled, it would be well for him to say a few words as to the origin of the series of lectures which they were about to inaugurate. It was something like two years ago that the Council of the Society resolved to institute a lecture, to be called the Quekett lecture, in honour of the late Professor John Quekett, and to be delivered from time to time by eminent microscopists; and it was thought that in memory of these occasions it would be well to present to the lecturer the Quekett medal of the Society, for which dies had been some time ago prepared, but which had not hitherto been utilized. Various circumstances had intervened to prevent this arrangement from being carried out; but at length they were met together to hear the first Quekett lecture, which was to be

delivered to them that evening by Sir John Lubbock, on whom he had great pleasure in calling.

Sir John Lubbock, Bart., M.P., F.R.S., &c., who was received with hearty applause, having expressed his sense of the honour conferred on him by the Council in selecting him as the first Quekett lecturer, proceeded to deliver his lecture "On some points in the Anatomy of Ants." The subject was well illustrated by a number of coloured diagrams enlarged from microscopic sections and preparations, and also by a series of beautifully executed drawings, which were placed upon the table. The lecture will be printed in a future number.

The President was quite sure he should express the wish of every one present in proposing a hearty vote of thanks to Sir John Lubbock for his very interesting and instructive lecture. He had himself listened to it with very great pleasure, and had no doubt that it had been listened to with equal pleasure by all who were present. He therefore proposed that they should all join in a vote of thanks for the very able lecture which they had been privileged to hear.

Mr. Charles Brooke said that he also had been very much interested by the lecture, and greatly pleased with the very able manner in which the anatomical structure of so minute an animal had been described. He hoped that, as time went on, their learned lecturer would be able still further to follow out his interesting subject, and that they might hope to hear some more of the results of his investigations at a future date. He had very great pleasure in seconding the vote of thanks to Sir John Lubbock.

The vote of thanks was then formally put to the meeting by the President, and carried by acclamation.

The President said that he had now the pleasing duty to perform of presenting the Quekett medal to the lecturer of that evening; and, addressing Sir John Lubbock, he expressed the very great pleasure he had in presenting it to him in the name of the Council and of the Fellows of the Society; and he could not help expressing also his gratification at the opportunity thus afforded of doing honour to one whom it was his privilege to regard both as a personal friend and as a man of science.

Sir John Lubbock, in reply, assured the Council and the Fellows that he felt very highly the honour conferred upon him in having been requested to deliver this lecture. He should preserve the medal with some degree of pride, and his family would preserve it as a much-prized memorial of the proceedings of that evening; and he would further say, that if anything could enhance its value in his estimation, it would be the fact of his having received it from the hands of his highly esteemed friend, the honoured President of their Society.

Scientific Evening, April 3, 1877.

Exhibitors and Objects.

The President, H. C. Sorby, Esq.: Specimens showing the application of the microscope to the determination of the index of refraction of minerals. Remarkable characters of double refracting crystals.

Mr. J. W. Bailey: A folding microscope of new pattern.

Mr. Charles Baker: Lord G. S. Osborne's new diatom exhibitor.

Messrs. R. and J. Beck: *Pleurosigma formosum* upon a black ground, with an achromatic eye-piece and patent achromatic condenser. *Surirella gemma*, with $\frac{1}{10}$ immersion with central stop and patent condenser. New form of small microscope, with concentric rotating stage, &c. Large portable microscope, with apparatus and objectives complete.

Mr. Badcock: *Megalotrocha albo-flavicans*, &c.

Mr. John Browning: Absorption spectrum of bromine.

Mr. Charles Collins: Young hippocampi in four stages of development.

Mr. Henry Crouch: Vegetable preparations double stained by Dr. J. G. Hunt, of Philadelphia.

Mr. Enoch: British trap-door spider, *Atypus sulzeri*, and spinnerets of spider.

Mr. F. Fitch: Some very beautiful natural mounts of insects.

Mr. W. H. Gilburt: *Asplemium bulbiferum*, stained.

Mr. J. W. Goodinge: *Pleurosigma angulatum*, with $\frac{1}{16}$.

Dr. Gray: Rare diatoms from Santa Monica.

Mr. H. Hailes: Foraminifera, *Spirillina vivipera* var. *Magaritifera* and *Chilostomella ozizeki*, &c.

Messrs. J. How and Co.: Dolerite intrusive in granite, trachytic lava, and carboniferous limestone.

Mr. Thomas Howse: *Peziza bicolor* alive, and a section of the seed of *Collomia grandiflora*, showing delicate spiral threads which surround the testa.

Dr. Lawson: Transverse section of human spinal cord, and *Microsporon furfurans*, a fungus that attacks the hair and skin.

Mr. W. G. Lettsom: Decomposed glass from Pompeii, mounted by Sir David Brewster; and a section of a Cornish mineral which shows the bands due to Didymium.

Mr. R. T. Lewis: Rheea fibre under the microscope.

Mr. S. J. McIntire: Eye of drone-fly.

Dr. Millar: *Mylinsia Zittelli* and *M. Grayii*, recent representations of ventriculites.

Mr. Moginie: Living organisms.

Mr. S. Norman: Spicula of *Dendrospongia Sturii*, human brain, and precious opal.

Mr. Thomas Palmer: Micro-spectroscope and chemical changes in substances.

Mr. W. W. Reeves: Young crinoid larvæ of Antedon on *Bugula flabellata* from Torbay, lent by Major Lang.

Mr. Sigsworth: Section of hoof of the horse, showing the papillæ.

Mr. H. J. Slack: Section of fossil bone from Tilgate Forest, and bulbs of Krupp's silicate cotton.

Mr. Charles Stewart: Ovary of *Dorocidaris papillata* and *Aspergillus glaucus*.

Mr. Amos Topping: Injected drum of ear of frog; ditto lung of frog; and ova of ditto, in different stages of development.

Mr. F. H. Ward: Section of corn from toe, cornea of pig, and *Toenia grandis*, stained.

Mr. Tuffen West sent some very beautiful drawings of the following objects.

List of Drawings.

Zoea, from Indian Ocean. *Sarcopsylla*, from fowl, Ceylon. *Nycteribia*, vampyre bat. *Nycteribia*, details. *Nycteribia*, winged, from Ceylon. *Larva*, Melöe. *Acadus destructor*. *Acadus plumosus*. *Acadus* from *Hydrometra*. *Pachygnatha* sp. Acarus (new?) from moss. *Tetranychus* from rosebush. Acarus from chaffinch. Acarus from tropic bird. *Listrophorus*. *Uropoda*, miniature. *Uropoda*, mature. *Uropoda* from bat. *Hypopus* from bee. *Gamasus* from fly, sheep, ferncase, English snake. *Pteroptus*, Ceylonese bat. *Argas foliaceus*. *Argas Fischerii*. *Ixodes* from tortoise, boa constrictor, Indian snake, black bear, dog (*I. Dugesii?*), elk, ferret (*I. ricinus*), Indian goatherd, ox, South America (*I. nigua*), unknown tortoise (rostrum).

Donations to the Library and Cabinet since April 4, 1877:

	From
Nature. Weekly	*The Editor.*
Athenæum. Weekly	*Ditto.*
Society of Arts Journal	*Society.*
Report and Abstract of Proceedings of the Croydon Microscopical Society, 1876	*Ditto.*
Bulletin de la Société Botanique de France. 2 parts	*Ditto.*
Description of Selected Specimens sent to the International Exhibition at Philadelphia, 1876, by the Medical Department, U.S. Army	*Department.*
Smithsonian Report, 1875	*Institution.*
3 Slides prepared by Dr. Christopher Johnstone, of Baltimore	*Dr. Johnstone.*

WALTER W. REEVES,
Assist.-Secretary.

MEDICAL MICROSCOPICAL SOCIETY.

Friday, March 16, 1877.—Henry Power, Esq., President, in the chair.

Adeno-Sarcoma from Nose.—Mr. Crook exhibited a specimen of this disease, removed on two occasions from the nose of a girl. The growth itself presented glandular structure, small cell growth, and a very large quantity of blood-vessels. He remarked upon its peculiar situation, viz. on the floor of the nose, at its junction with the septum.

Cochlea in Birds.—Dr. Urban Pritchard described and exhibited specimens of the cochlea in birds, particularly that of the magpie. He described it as a short straight tube, ending in a cul-de-sac, and not spiral as in mammals; and when examined in transverse section it presented on one side a quadrilateral cartilage and on the other a triangular one (= the ligament of the cochlea in mammals). Stretched between them were the Membrana tectoria, and M. Basilaris, enclosing the organ of Corti.

The auditory nerve ran up the length of the cochlea, adherent to one wall; on section, the ganglion-cells could be seen in between the

nerve-bundles. The ultimate nerve-fibres were given off at right angles, and piercing the quadrilateral cartilage *en masse*, ended in fine fibres between the hair-cells in the organ of Corti.

The very end of the cul-de-sac was lined with "vestibular cells," showing thus a marked difference between the birds' and mammalian cochleæ.

On the triangular cartilage were columnar epithelial cells, going on over the Membrana Basilaris, while on the quadrilateral cartilage were hyaline cells, that filled the sulcus on its border, and corresponded to the limbus in the mammalian cochlea. In answer to several questions, Dr. Pritchard described his mode of preparing the cochlea. Taking a small one, as a bird's, he thus proceeds:

1. Place at once in methylated spirit.
2. In alcoholic solution of chromic acid ($\frac{1}{3}$rd per cent.) for five to ten days.
3. In 1 per cent. solution of nitric acid, constantly agitating the liquid, for one to four days.
4. Wash: transfer to gum and water for some hours.
5. In methylated spirit till wanted.
6. Imbed: cut section: stain: mount in glycerine.

April 20, 1877.—Henry Power, Esq., President, in the chair.

Double Staining with Indigo Carmine and Carmine.—Mr. Golding-Bird read a paper upon this subject. He referred to an account of it in the 'American Journal of the Medical Sciences' for January 1877, though it was originated by F. Merkel in Germany in 1874.

He described the dye as consisting of two fluids made separately, but mixed before use; one was a boracic solution of carmine (carmine, ʒss; borax, ʒij; distilled water, ℥iv); the other, a similar solution of indigo carmine (indigo carmine, ʒij; borax, ʒij; distilled water, ℥iv). Indigo carmine is the trade name for sulphindigotate of potassium, and is the same dye as used by Chrzonszczewsky in his researches upon the commencement of the portal duct.

The specimens to be stained, if hardened in chromic acid, must be deprived of it by washing, and then immersed in the mixed dyes for a quarter of an hour. After that they must be transferred to a saturated solution of oxalic acid, both to "set" the blue colour as well as to lighten the general tint, and then, having been washed in distilled water, mounted in Canada balsam in the usual way.

The results obtained by this process, when successful, were both instructive and beautiful, but unfortunately the same results did not always follow, a great number of specimens showing often nothing but a general purple tint resembling a successful logwood stain.

The author showed, however, several slides in which he had obtained the double stain more or less perfectly. One specimen of liver showed the portal canal remarkably well; the blood-disks in the portal vein were of a brilliant apple-green; the hepatic artery, reddish purple; the process of Glisson's capsule, blue or blue purple; and the portal duct had its wall of the same colour but of a different tint, the columnar cells lining it being just tinged a brownish purple with blue nuclei. Another specimen of ossifying cartilage showed the various component parts sharply picked out in blue, purple, red, and light green.

The cause that the author suggested for the failure of the dye on some occasions was the imperfect action of the oxalic acid; for while it was necessary to fix the indigo blue, it effectually destroyed the carmine by either precipitating it or turning it into a straw colour.

He did not consider the process as yet perfected, but hoped that by finding some other reagent than oxalic acid, that would possess its good without its deleterious properties, a more uniform and certain result might in all cases be ensured.

From what he had seen, he thought that there was every promise of obtaining important and instructive results from this new dye; as, when successful in its action, it was a true physiological stain and not merely a general one.

He also recommended, as a general dye, the use of the blue boracic solution of indigo carmine by itself; it stained rapidly, was sufficiently well fixed by the oxalic acid process, and was a colour most agreeable to work with. He had employed it as an injection, but though it ran well along the vessels, it was very difficult to fix in them, as it rapidly transuded and stained the surrounding tissues.

Mr. Crook had tried the double dye, but not sufficiently extensively to speak positively as to its action.

Mr. Needham, though he thought a double dye, in one fluid, most valuable, had been disappointed in double dyes generally. Picrocarmine was not constant in its action.

Mr. Ward spoke of double staining with two aniline dyes, especially for vegetable substances. He had found the colour permanent if the specimen were immersed in benzine after being in oil of cloves.

Fibroma of hard Palate.—Mr. White showed a specimen of this tumour under the microscope. He also exhibited a cast showing the tumour *in situ*. It was about the size of a pea, and grew from the hard palate just behind the incisor teeth. He especially remarked upon its unusual situation.

Tumour of Conjunctiva (? small-celled sarcoma).—The President related a case, illustrated by drawings and specimens, of a tumour of the conjunctiva. It occurred in a patient over sixty years of age, and first appeared at the edge of the cornea, which structure it involved later on. Though removed several times, it still recurred, and even appeared again on the stump of the optic nerve after enucleation of the globe.

Quekett Microscopical Club.

Ordinary Meeting, March 23, 1877.—Dr. John Matthews, F.R.M.S., Vice-President, in the chair.

Three new members were elected, four gentlemen were proposed for membership, and numerous donations were announced and acknowledged.

A letter relating to the "Blyborough Tick" was read; and in reply to inquiries from the writer, Dr. M. C. Cooke mentioned that most of the creatures of that family possessed six legs only in their early stages, but afterwards had eight; and he named several works to which reference might be made for further information.

Mr. W. H. Gilburt read a paper "On the absence of Stomata from

certain Ferns," and gave an account of his examination of many species of the Filmy Ferns—*Hymenophyllaceæ*, *Trichomanes*, and *Todea;* in each of which these organs were wanting. The specimens had been prepared by both bleaching and double staining, and a selection from them were exhibited in the room in illustration of the paper.

Mr. T. C. White called attention to a curious organ which he had frequently observed to be attached to the third segment from the tail of a species of marine Cyclops, and which until lately had been examined without success as to the discovery of its use or nature. Recently, however, Mr. White had been fortunate in determining it to be a spermatophore, and had seen under a $\frac{1}{8}$-inch objective spermatozoa in active motion, which had just escaped from a crushed specimen under examination.

The attention of the members was particularly requested to the arrangements made for the soirée of the club to be held on April 13, and the meeting closed with the usual conversazione.

Ordinary Meeting, April 27, 1877.—Henry Lee, Esq., F.L.S., President, in the chair.

Four new members were elected, ten gentlemen were proposed for membership, and a number of valuable additions to the library and cabinet were announced.

Communications were read—from Mr. Bridgman respecting a new tinted glass which he had been successful in obtaining, and concerning which it was hoped that additional particulars would be furnished at a future date; also from members of the Excursion Committee, giving short and interesting reports of the field excursions of the club to Barnes on March 24, and to Snaresbrook on April 7.

Mr. T. C. White read a paper on *Botryllus*, in which, after briefly enumerating the characteristics of the Tunicates, he gave the results of his personal observations on the life-history of specimens developed in his marine aquarium, the chief point of interest being the discovery of a method of progression which did not appear to have been previously noticed. The subject was well illustrated by drawings.

Mr. Charles Stewart added some useful information as to the best methods of preparation, preservation, and mounting these organisms, and

The President expressed a hope that Mr. White would continue his very useful investigations, and promised him such supplies of material from the Brighton Aquarium as his influence could procure.

The proceedings terminated as usual with a conversazione, at which a number of interesting objects were exhibited.

Microscopical Section, Royal Society,* New South Wales.

The above Section, in conjunction with others of the Royal Society, each having for its object some specific branch of scientific inquiry, held its first meeting on June 23, 1876, and during the rest of the

* If the Secretary will send us brief records of the papers read we shall gladly insert them, but we have not space for a general discussion of the subject of societies in general, which he has sent us at present, and which we cannot insert.

year regular monthly meetings have been held, with large attendances of members. A large cabinet has been purchased, and many valuable contributions of slides have already been received. A first-class microscope stand, to be placed in the Society's room, has been ordered, and members belonging to the Section will have the privilege of using it for any special branch of investigation for which their own means might prove inadequate. During the session the following papers have been read:—On the Action of Alkali on Wood Fibres, by Mr. G. D. Hirst; The Starch of the *Macrozamin spiralis*, Dr. Milford; On Exostosis of the Human Tooth, Mr. H. Paterson; Note on a Species of Chelifer, Mr. G. D. Hirst; On two Species of Insectivorous Plants indigenous to the Colony, Mr. J. N. C. Colyer; The Milky Juice of the Climbing Fig, Mr. H. J. Brown.

San Francisco Microscopical Society.

The regular meeting of the San Francisco Microscopical Society was held January 4.

The Society will soon have in its cabinet a complete series of Professor H. L. Smith's diatom slides, including the five "centuries" issued by him, which will be a valuable acquisition.

The feature of the evening was a lecture by Dr. Gustaf Eisen, Professor of Zoology, University of Upsala, Sweden, one of the Society's corresponding members, who called attention to a collection of worms of the family *Enchytræidæ*, order *Oligochæta*, sent to him by the eminent Arctic explorer, Professor A. E. Nordenskiold, in Sweden. The worms were collected during the last Swedish expedition to Siberia and Nova Zembla, and especially from the neighbourhood of the river Jenissej. Dr. Eisen exhibited some twenty plates of drawings, containing about one hundred and fifty different figures of the various organs of said worms, and illustrated his descriptions by various microscopical slides. The principal points of interest were the following:

The collection contained about eighteen species, or perhaps more, as the whole of the material was not as yet worked up. Of those species, none were previously known or elsewhere described. From Germany three or four species of the same genus have been sufficiently well described to be identified, but none of them have been identified with any in the collection from Siberia.

In the course of his remarks, Dr. Eisen stated that the inner organs of said worms differed very much in size and shape, and furnished the only characteristics by which the species could be distinguished from each other, as no external characters of sufficient value existed. One of the best characteristics is furnished by the size and shape of the nervous system, and especially by the foremost part of the supra-œsophagial ganglion or brain. By studying the organization of the different species, one could guess at or even form an idea of the development of the whole genus. For instance: the brain of said worms must originally have consisted of only a slight swelling of the ventral ganglia or nerves, of which the two parts had not as

yet grown perfectly together or been differentiated to any higher degree. In such a state of development was yet one of the exhibited species called *Enchytræus primævus*. In fact, by looking at the different species, a perfect series could be seen of the different states of the development of said ganglion or brain. In *Enchytræus nasutus* the differentiation was larger, as the two halves of the brain here were wholly grown together, but still leaving some traces of their former state by being concave both in front and behind. In *Enchytræus Stuxbergii* the differentiation was perfect, as the brain here was convex in front. Said worm was also considered to be more highly developed and organized than any of the other species of the same genus and family. Accordingly, he separated the many species into three tribes, of which the first or lowest had the brain concave in front and behind; the second had the brain concave behind, but even in front; and again, the third or highest standing tribe had the brain convex both in front and behind.

In the worms which were hermaphrodites were found organs of generation of two kinds—male and female. The female organs consisted of, first, ovaries containing eggs in different states of development, and second, of a pair of receptacles for the spermatozoa, peculiarly shaped, and varying in size and form in different species. The ovaries were generally found in the twelfth segment, the receptacles again always in the fourth segment of the worm counted from the head or the mouth. The male organs consisted of first, testes producing the spermatozoa, and second, of a pair of efferent ducts through which the spermatozoa were carried to the outside of the body and from there to the receptacles in the front part of the worm, where they were stored up in large quantities for future use. The testes were situated in or near the eleventh or twelfth segments, the efferent duct was always found in the eleventh segment.

The minute anatomy and histology of said organs were shown partly by drawings, partly by microscopical slides previously prepared. The shape and development of the receptacles for the spermatozoa furnished good characters by which the different species could be recognized.

The system of circulation was very simple, and consisted only of a single ventral vessel uniting itself with a dorsal one in the front part of the body. The blood was either red or white, the last the most frequent. The lymphatic system was simpler yet, as here no vessels at all occurred, the lympha floating free in the perivisceral cavities of the body. The lymphatic fluid contained corpuscles resembling the blood-corpuscles of the higher animals, and in each species a different form of said corpuscles existed, giving good characters for the distinction of the species.

Dr. Eisen stated that he had also found several species of the same genus *Enchytræus* in California, and called the attention of the members of the Society to the value of even the smallest contributions to a collection of California *Enchytræi*, which he was forming and soon intended to work up. The said worms were frequently found in moist earth, in flower-pots, under decayed seaweeds, &c.,

and were generally of a pale whitish colour, and in size seldom exceeding that of a common pin. The worms could best be preserved in alcohol.

A meeting of the Society was held on Thursday evening, January 18, with President Ashburner in the chair.

Mr. J. R. Scupham presented a quantity of diatomaceous earth, obtained by him from Fort Hill, Los Angelos, which was examined somewhat hastily during the evening, and found to contain great quantities of fragments of *Coscinodiscus*.

Mr. A. Burdick exhibited a slide mounted by him, showing a minute portion of the thallus of a marine Algæ from Monterey Bay, to which was attached four species of diatoms. One of them, a *Hyalodiscus*, would not reveal its beautiful markings till quite a high power and proper illumination were brought to bear, when it surrendered, and its fine and well-defined lines reminded the observer of the lathe work on the back of a watch-case.

Colonel Kinne exhibited several slides from his box of duplicates, one of antelope hair in balsam, showing the peculiar cellular structure of the investing membrane and enlarged medullary portion, which, though not new, attracted considerable attention.

The annual meeting of the San Francisco Microscopical Society was held on Thursday evening, February 1, President Ashburner in the chair.

As the only business of the evening was properly that pertaining to reports from retiring officers and the election of officers for the ensuing year, of course there was but little of scientific interest aside from that gathered in the report of the President, which was of considerable length, and furnished a very full and intelligent abstract of the doings of the Society for the past twelve months.

Dr. A. M. Edwards was called upon, and, after some remarks of general interest, he spoke of the scourge now visiting our city in the shape of diphtheria, and after some extended remarks, which interested all present, particularly Doctors Mouser, Whitney and Burgess, he alluded to the great satisfaction with which he had treated many cases in the East, with a solution of salicylic acid, applied in the shape of a spray. He exhibited a series of drawings from the microscope, which faithfully portrayed fungoid organisms, illustrative of diphtheric growth. The salicylic acid invariably caused the disappearance of fungal matter, and ultimately the disease was checked.

Mr. J. P. Moore, in this connection, spoke of the use, by himself, of the same acid as a remedy for poison oak, and though he had heretofore been tortured by the poison on many occasions, by the use of salicylic acid he now could cure the disease without trouble, while, applied as a preventive, he was able to pursue the agile *agaric*, even under the protecting branches of the poisonous shrub itself, without fear of the consequences.

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